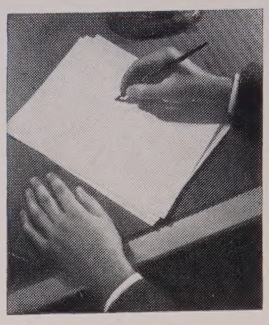
Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

AUGUST 1952



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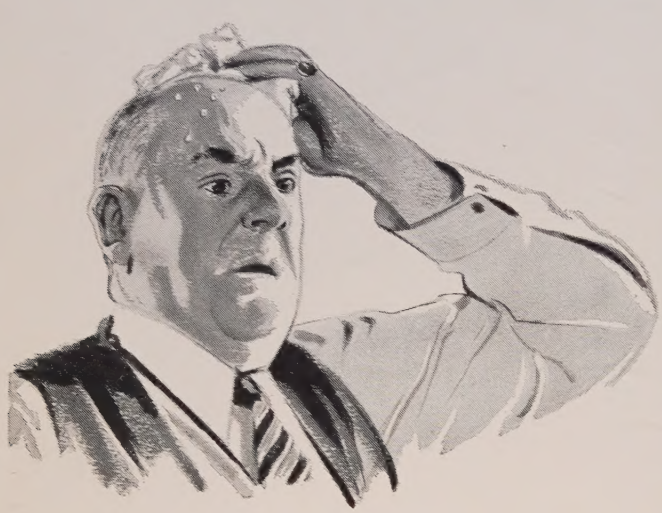

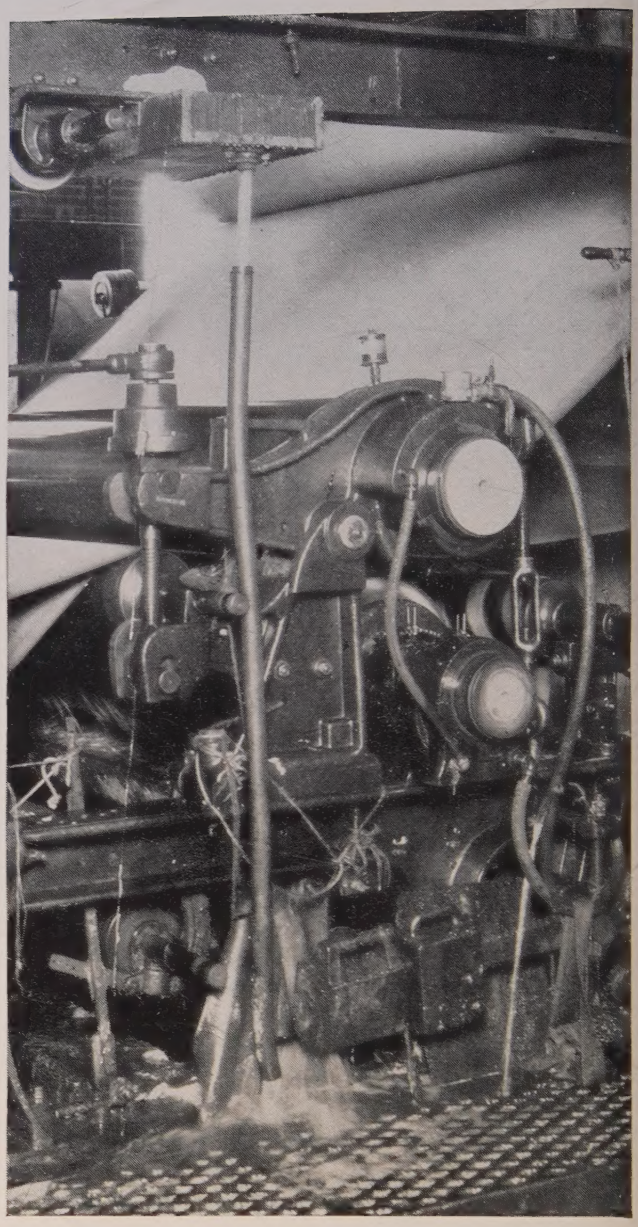

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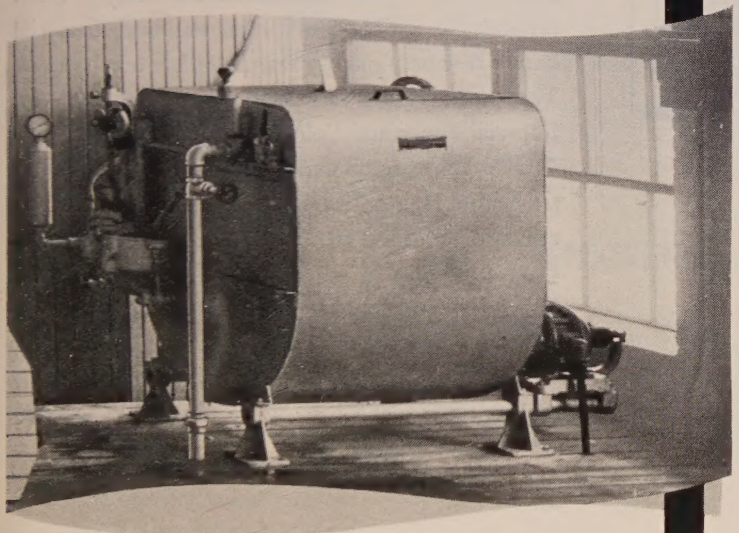

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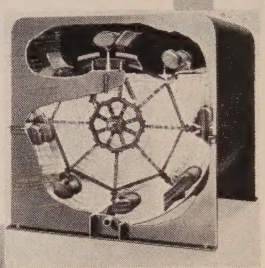
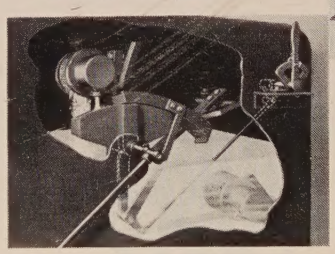


Below
Chemical measuring cup discharging through orifice into the collector funnel. The cut-off shield above the collector funnel can be positioned by the manual variator to change chemical feed quantities.



Above
Infilco Mixer and Feeder with section tank cutaway to show unique plow-shaped agitators, chemical measuring cups and collector funnel.

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TECHNICAL ARTICLES

Fourdrinier Section Load Requirements, *by W. Mikelson* 337

Dyeing Paper White, *by M. C. Hutchins, E. I. Stearns, and F. O. Sundstrom* 342

Straw Pulp Wood Pulp Blends for Various Types of Papers, *by S. I. Aronovsky, A. J. Ernst, R. J. Seidl, and R. M. Kingsbury* 351

A New Method for the Addition of Neoprene Latex to Paper Pulp, *by J. R. Galloway, R. H. Walsh, J. Burt, J. S. Hickman, and R. E. Shrader* 357

Acid Pulping—Strainer and Circulation Survey, *by John M. McEwen* 361

Some Observations on Sulphate Turpentine Recovery, *by M. R. Dusenbury and John E. Reese* 365

Studies of Variability in a Kraft Mill, *by Howard W. Stephen* 367

Improved Diffuser Washing—Markila-Brax Strainers and Angle Iron Supports, *by K. F. Gothner and H. T. Robson* 370

Dye Adsorption on Wood Pulp. I. Adsorption of Direct Dye on Unbeaten Sulphite Pulp, *by J. W. Beamesderfer, E. F. Thode, A. J. Chase and R. E. Hubbard, Jr.* 374

Dye Adsorption on Wood Pulp. II. Relation of Dye Adsorption to Physical Properties of Beaten Sulphite Pulp, *by E. F. Thode, J. W. Beamesderfer, and A. J. Chase* 379

DEPARTMENTS

United States Requirements of Wood Pulp for Papermaking, *by James L. Ritchie* ..... 10 A
Folding Carton Forum
Manufacturing Board for Folding Cartons, *by John P. Weidner* ..... 20 A
Folding Carton Manufacturing Problems, *by F. W. Stowetts* ..... 24 A
Meeting the Customer's Requirements for Folding Cartons, *by Walter Sooy* ..... 28 A
Folding Cartons from the Customer's Viewpoint, *by W. L. Romney* ..... 32 A
Testing Procedures for Folding Cartons, *by L. R. Ayers* ..... 36 A
Development of Folding Cartons, *by Howard S. Gardner* ..... 42 A
The Future of Folding Paper Cartons, *by R. A. Irwin* ..... 48 A
Cooperative Research for Carton Industry Development, *by Lewis K. Burnett* ..... 56 A
Association News and Events ..... 67 A
Recent Books ..... 68 A
Personal Mention ..... 70 A
Obituaries ..... 98 A
Local Section Activities ..... 99 A
Letters to the Editor ..... 132 A
Reports and Discussions ..... 133 A
TAPPI Standards
Bursting Strength of Paper. Proposed Revision of TAPPI Official Standard T 403 m-47 ..... 145 A
Specific External Surface of Pulp. Proposed Revision of TAPPI Suggested Method T 226 sm-46 ..... 147 A
Pulp and Paper Mill Lubricant Specifications, *by A. I. Sippola* ..... 150 A
Factors Affecting Chipper Knife Performance, *by Harold F. Wood, Jr.* ..... 153 A
Instrumentation Studies. LXXXIII. A Summary of Instrumentation Reports Including the Technique of Evaluating Instruments, *by George R. Sears, Willmer A. Wink, and J. A. Van den Akker* ..... 156 A
Employment Service ..... 192 A
Calendar of TAPPI Meetings ..... 193 A

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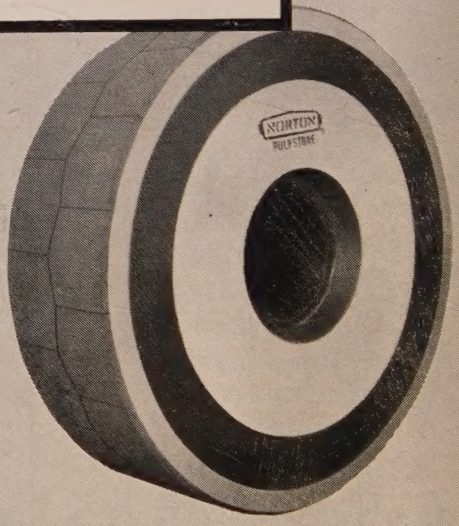

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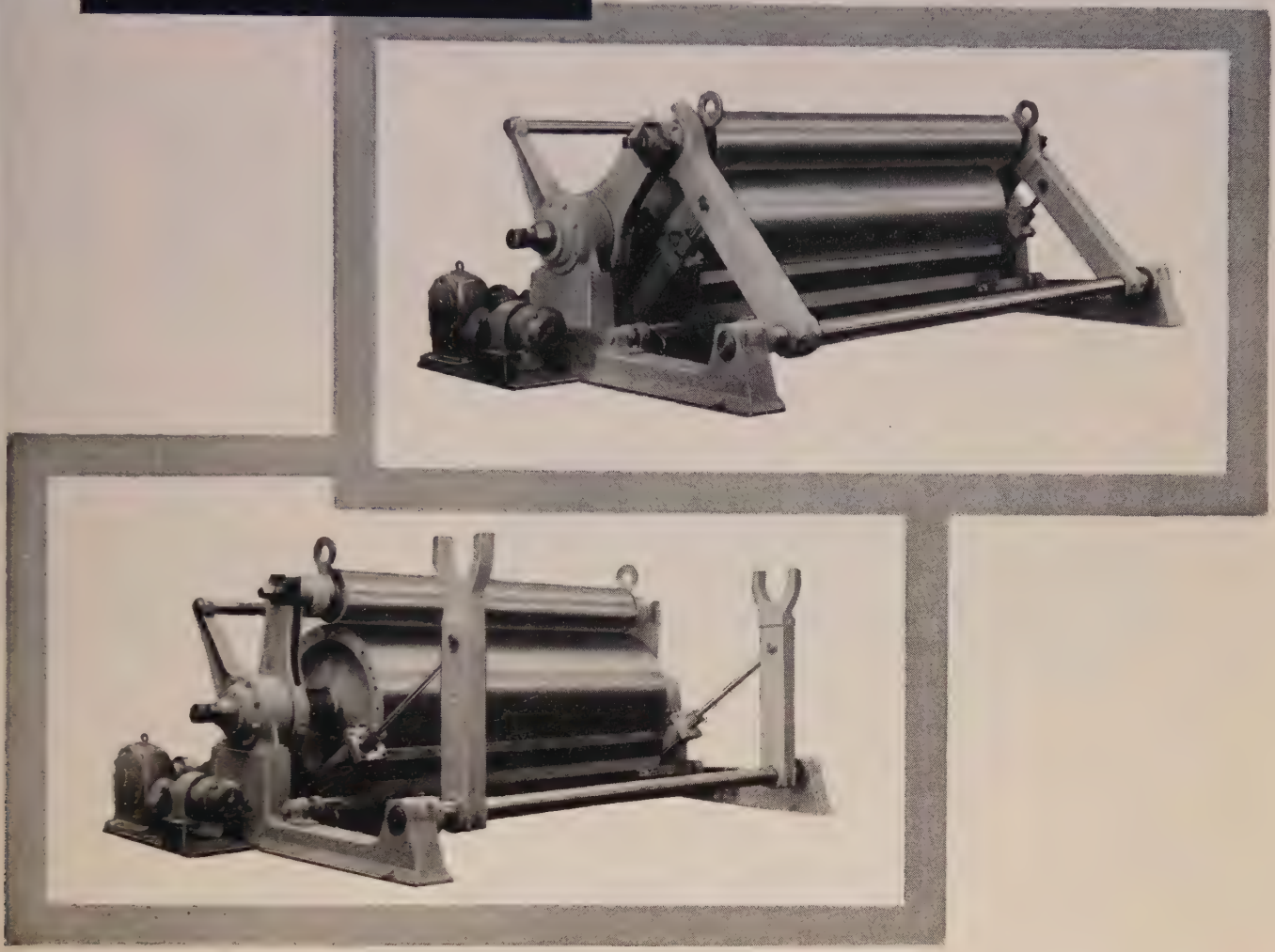

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United States Requirements of Wood Pulp for Papermaking

JAMES L. RITCHIE

THERE is perhaps no one here today that is not more or less directly dependent upon wood pulp for his livelihood. This distinction we share with a host of other Americans whose economic future is tied to this basic processing material.

Based on the latest available Census data, four pulp-dependent industries—the paper industry, the rayon industry, the printing and publishing industry, and the converted paper products industry—account for one tenth of the economic wealth generated annually by the entire American industrial economy. Together, these industries employ $8^1/_2\%$ of all industrial wage earners; their combined payrolls are equal to 9% of the aggregate payroll of the entire American industrial economy.

Additional economic values are directly added to wood pulp by the cellophane industry, the plastics industry, the munitions industry, the photographic industry, and the paint industry; indirect economic values accrue from pulp by-products and from pulp supporting activities in the allied wood, chemical, and machinery and equipment industries.

There is no better example in American industry of the effective utilization of a basic natural resource for the improvement of America's standard of living. Economic and social values pyramid as this basic material moves successively through various stages of conversion.

It is against this social and economic background that we must view basic trends and developments in the domestic wood pulp industry.

OUR FOREST RESOURCES

Since the long-range growth of all forest products industries will be dependent upon the continued availability of adequate supplies of wood, the outlook for forest resources will, in large measure, determine whether our growing requirements of forest products, over the long term, can continue to be satisfied.

Fears to the contrary notwithstanding, there is ample evidence to support the view that American forests will continue adequate to supply this country's growing requirements of forest products, including wood pulp.

To *insure* the continuous satisfaction of our long-range need for forest products, however, there must be (1) a more effective utilization of our available forest land, and (2) a more complete utilization of our current supply of wood resources.

The domestic wood pulp industry is making notable progress along both of these lines.

UTILIZATION OF FOREST LAND

At the beginning of the twentieth century, approximately one third of the land area of the United States was forested. Forest lands *still* constitute about one third of this country's total land area. There has been no significant shrinkage, therefore, in the land area available for the growth of our national wood requirements.

Further, annual growth on our available forest land area is currently much greater in volume than it was 50 years ago. Much of the wood cut from our forest land around the turn of the century was slow-growing virgin timber; most of the wood currently cut from our forests is relatively faster growing second-cut stock. As we continue to rely more heavily on second-growth wood, the yield from our forest land areas will continue to rise.

Several other factors are resulting in an improved utilization of our available forest land: (1) improved protection against fire, insects, and disease; (2) more extensive tree planting programs; (3) more intensive forest management programs; and (4) more energetic efforts to acquaint the public with the need for forest conservation. Continuing gains in the productivity of our forest land areas may be expected as these programs bear fruit.

In all of these programs, the domestic wood pulp industry has played an active and aggressive role.

EFFECTIVE UTILIZATION OF WOOD RESOURCES

More effective utilization of our available wood resources is also helping to insure that our mounting requirements of wood pulp will not be jeopardized by a static wood supply.

Programs directed toward an improvement in wood utilization in the wood pulp industry have been of two types:

1. Programs designed to broaden the range of wood species suitable for use in pulp manufacture.
2. Programs designed to insure more complete utilization of the pulpwood log, through a continuing attack on fiber waste.

Utilization of New Pulping Species. The problem of finding new wood species suitable for wood pulp manufacture has been a recurring problem that is as old as the wood pulp industry itself.

A hundred years ago, for example, paper was in critically short supply and the industry was searching for suitable fibers to supplement rags as a raw material for papermaking. Research found the answer in our extensive spruce forests, and the industry's basic problem soon became one of oversupply. Market research and sales promotion, in due course, solved that problem so well that the available supply of spruce was soon no longer adequate to enable the industry to meet its sales obligation, and fiber shortages again became the limiting factor in the paper industry's growth. Again technical research found the answer—this time in West Coast hemlock and fir—and again the industry's prob-

JAMES L. RITCHIE, Executive Director, United States Pulp Producers Association, Inc., New York, N. Y.

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lem became one of oversupply. In due course, market development overcorrected this new unbalance, and the need for still more fibers for papermaking to relieve shortages was again with us. This time research found the answer in southern pine, and for good measure broadened the industry's long-range horizons by developing new pulping processes designed to insure the ultimate utilization of vast reservoirs of hardwoods.

By developing pulping processes that permit use of a broader range of pulping species, the domestic wood pulp industry would appear to have met effectively for some time to come the recurring threat of domestic fiber shortage.

The Attack on Fiber Waste. Remarkable progress has also been made in recent years toward a more complete utilization of the pulpwood log. There have also been two main lines of approach in the wood pulp industry's attack on this problem of fiber waste:

1. Methods for harvesting, handling, and preparing wood for use in the pulp mill have been improved.

2. Pulping processes designed to insure higher fiber yield from the processed wood have been developed.

Notable gains in fiber conservation have been effected in all pulp-producing regions through the development of fiber saving mechanical processes for harvesting, transporting, and preparing wood for use in the pulp mill; through increased utilization of sticks of small dimensions, heretofore regarded as uneconomic for pulp production; and through increased use of waste woods from other forest products industries.

The whole log hydraulic barker and the whole log chipper, first developed about 1945 and now in general use on the West Coast, have resulted in an estimated 20% improvement in West Coast wood utilization, over and above savings that have been effected by other devices.

Not many years ago, only about one third to one half of the pulpwood log remained after it had been prepared for ultimate processing in the pulp mill. Gradually, the industry is moving toward an ultimate goal of complete utilization of the usable fiber in the pulpwood tree.

The development of pulping processes designed to insure higher fiber yields from the prepared pulpwood has been rapid despite the relatively recent origin of these processes. The production of wood pulp by these high yield pulping processes has doubled since 1945. Indications are that facilities for the production of pulps of this type will continue to expand rapidly with consequent further improvement in the industry's over-all fiber utilization.

ADEQUACY OF WOOD SUPPLY FOR THE FUTURE

By continually broadening the range of species suitable for domestic wood pulp production and by steadily improving the ratio of recoverable fiber to the total volume of standing wood, the domestic wood pulp industry is materially broadening the long-range horizons of its dependent industries. By imparting a new elasticity to our standing wood supply the wood pulp industry is obviating any early return of restrictive fiber shortages and making possible an expansion of all pulp-dependent industries that will insure the satisfaction of maximum foreseeable demands for products produced from wood pulp.

In the ability of the wood pulp industry to impart important economic values to wood species that have heretofore had little or no economic value and in its ability to utilize more and more of the reclaimable fiber lies real promise for a continuing long-range growth of the pulp industry, even if over-all shortages of wood resources should ultimately become a national problem. Other major forest product industries have substantially less flexibility than the wood pulp industry in their endeavor to achieve a maximum wood utilization, and their assured long-range raw material supply, as a consequence, is far less elastic.

The domestic wood pulp industry is currently using about 14% of the total volume of wood harvested annually from America's forests; twenty years ago it was using only about 5%. Canada and Sweden are currently using over one third of their total forest cut for wood pulp. Practical considerations of forest economics, as well as social considerations, may well dictate a continuing long-range trend toward an increasing diversion of United States forest resources to wood pulp production.

THE GROWTH OF WOOD PULP REQUIREMENTS

This country's requirements of wood pulp since 1935 have increased at an almost unprecedented rate.

United States consumption of wood pulp in 1951 totaled 18½ million tons, almost three times the level of consumption in 1935. Two factors have been responsible for this extraordinary growth in wood pulp requirements: (1) the growth in population and (2) the growth in per capita consumption of pulp products.

Population increases alone, since 1935, would have operated to increase our national wood pulp requirements by 21%. The actual increase in consumption during this period, however, has been 179%. Growth in per capita consumption of wood pulp, therefore, has been a far more important factor in the growth of our national wood pulp requirements than the growth of population—approximately 7½ times as important.

Per capita consumption of wood pulp since 1935 has increased at the rate of 8 lb. per capita per year. The rate of increase in per capita pulp requirements has been far greater than the improvement in over-all economic conditions during this period would have justified. Growth in the per capita consumption of wood pulp since 1935 has, in fact, been 52% greater than growth in the per capita consumption of our over-all national output.

To what is this extraordinary increase in the per capita consumption of wood pulp attributable? It is attributable primarily to the fact that wood pulp lends itself more readily than most processing materials to the development of important new products that are both functional and economical, and to an ever broadening range of end uses.

Increased use of the functional fiber shipping container since 1935 and development of the paper shipping sack, for example, have significantly lowered packing and shipping costs for the whole American economy. Prepackaging techniques, based on the use of paper and paperboard including developments in the frozen food field, have revolutionized manufacturing and processing operations, completely changed the character and appearance of our retail stores, and, in practical effect, put

Too Big a Bite

Approximately 11% of the annual forest removal is caused by *drain* . . . the wood destroyed by fire, insects and disease. This is non-recoverable loss and is proving to be largely avoidable under today's modern forest management.

On the brighter side of the picture, is the fact that in the federal government's four forest appraisals made since 1909, the ratio between annual growth and loss by fire, insects and disease has decreased from 28.8% to 11%. Any further lowering of this drain factor will mean that timber growth will more than equal total removal.

Weyerhaeuser foresters, pioneers in tree farming, have established that successful operation of a tree farm depends first upon a fire protection system sufficiently effective to hold annual fire losses below an established maximum. In the case of Weyerhaeuser West Coast tree farms this allowable loss is ¼ of 1% of the acreage . . . as compared to 3.4% nation-wide average.

This is just one facet of the Weyerhaeuser forestry policy which is designed to insure a continuing supply of pulpwood for the Weyerhaeuser sulphite and sulphate pulp mills.

PULP DIVISION WEYERHAEUSER

a maid in every housewife's kitchen. Building boards and construction papers have had a phenomenal growth as the industry has successfully bid for a strong competitive position in the building field. New sanitary products have been largely responsible for an unprecedented growth in the tissue field. Rayon, cellophane, and other products of the chemical conversion industries, all based on wood fiber, have matured in the past 15 years as new products and new fields of use for older products have been developed.

Wood pulp has been a direct beneficiary of the energy that has been expended in the development, production, and sale of products, old and new, by the major pulp-dependent industries. This expenditure of human energy has resulted in a 132% increase in the per capita consumption of paperboard since 1935, a 342% increase in the per capita consumption of building papers and boards, and a 171% increase in the per capita consumption of tissue papers. The growth in per capita consumption of other major grades of paper, while less phenomenal, has nevertheless been substantial.

The growth in our national requirements of wood pulp has been a direct result of these developments in pulp-dependent industries; the composite demand for pulp products, obviously, must always determine the ultimate level of our national wood pulp requirement.

THE PATTERN OF WOOD PULP REQUIREMENTS

There have been significant changes over the years in the pattern of United States wood pulp consumption. These changes in the pattern of pulp consumption have been attributable not so much to the preferences of consumers as to changes in the relative availability of specific types of wood pulp. Relative availabilities of specific types of pulp, in turn, have depended primarily upon the particular species of wood that have happened at the time to be most freely available for conversion to pulp.

The pattern of United States wood pulp consumption is shown for representative years in the following table:

Pattern of United States Wood Pulp Consumption in Paper and Board Manufacture

	1919, %	*1935, %*	*1951, %*
Total sulphite	40.2	36.8	18.6[b]
Bleached	13.7	18.6[a]	11.8[b]
Unbleached	26.5	18.2[a]	6.8[b]
Total sulphate	6.6	30.7	52.5
Bleached and semibleached	0.9	3.1[a]	15.3
Unbleached	5.7	27.6[a]	37.2
Soda	9.9	6.4[a]	2.8
Groundwood	41.7	23.8	15.6
Other	1.6	2.3[a]	10.5
Total	100.0	100.0	100.0

[a] Estimated on basis of new supply, inventory changes, etc.
[b] Includes small quantity of dissolving sulphate consumed in production of paper.

It is apparent from the shifting pattern of pulp consumption that the term "requirements," as applied to wood pulp *must* be a fairly flexible concept. Growth factors, due to the character of our wood resources, are bound to vary significantly for the several types of wood pulp. A pulp supply that is adequate to meet our over-all national requirements may be quite inadequate as regards a particular grade of pulp. The problem, therefore, is one of "cutting the suit to fit the cloth." Individual consumers, as the industry grows, must be prepared to alter their specific wood pulp requirements within reasonable limits, so that over-all consumption will conform to any new pattern of available pulp supply that may evolve.

Past experience clearly indicates that changes in the pattern of our pulp supply need require no reduction in the production of end products and no deterioration in their quality. On the contrary, despite necessary shifts in the pattern of pulp consumption, the range of end uses of products manufactured from wood pulp is constantly broadening and the quality of these end products constantly improving—thanks to the fine team work of the industry's technical, production, and sales personnel.

THE PATTERN OF WOOD PULP SUPPLY

Our national requirements of wood pulp, for many years, have been met, in varying degree by United States, Canadian, and European pulp producers.

The relative importance of each of these supply sources has changed significantly since 1937, as well as the grade pattern of receipts from each of the regions of supply.

Changes in the relative importance of our respective supply sources since 1937 have been as follows:

Relative Importance of Supply Sources for Paper Grades of Wood Pulp

	From domestic sources, %		*From Canada, %*		*From Europe, %*	
	1937	*1951*	*1937*	*1951*	*1937*	*1951*
Bleached chemical pulps	75	82½	12	14½	13	3
Unbleached sulphite	43	56	8	54	49	10
Unbleached sulphate	76	95½	2	2½	22	2
Groundwood	88	89	9½	10	2½	1
Other	100	99	0	1	0	..
Total all grades	72	88	8	9	20	3

Our relative dependence upon foreign supply sources for the satisfaction of our over-all wood pulp requirements, therefore, has declined sharply in recent years; it will probably continue to decline.

Changes in the grade pattern of United States receipts of paper grades of *market* pulp, since 1937, have been as follows:

Grade Pattern of United States Receipts of Paper Grades of Market Wood Pulp

	From domestic sources, %		*From Canada, %*		*From Europe, %*	
	1937	*1951*	*1937*	*1951*	*1937*	*1951*
Bleached chemical pulps	30	57	20	30	30	13
Unbleached sulphite	12	15	7	64	81	21
Unbleached sulphate	5	38	7	32	88	30
Groundwood	11	19	66	69	23	12
Other	100	82	0	15	0	3
Total all grades	24	41	15	41	61	18

In these data a sharp trend toward North American self-sufficiency in market wood pulp is evident. While this trend toward continental self-sufficiency is also expected to continue, it is probable that imports from Europe will continue necessary for some years to come in order to insure, during periods of full operations, complete satisfaction of the needs of domestic non-

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THE GROWTH OF UNITED STATES WOOD PULP PRODUCTION

The growth of United States wood pulp production, more than any other single factor, has been responsible for the marked changes that have occurred in the pattern of wood pulp supply and requirements.

The year 1935 marked the beginning of a major expansion cycle in the domestic wood pulp industry, surpassing in scope anything that the industry had ever before experienced. For the next seven years wood pulp productive capacity, in response to expanding requirements, increased at an average rate of two thirds of a million tons a year; more than $3^1/_2$ times the predepression rate of increase in consumption.

Because of wartime restrictions on building, pulp capacity from 1942 to 1946 was relatively dormant. Beginning with 1946, however, the interrupted prewar expansion cycle was resumed, and the domestic pulp industry's postwar rate of growth reached a new all-time high. From 1946 through 1951 the domestic pulp industry expanded its productive capacity at an average rate of over a million tons a year, over six times the predepression rate of increase in consumption. The end of this major expansion cycle is not yet in sight.

The annual capacity of the domestic wood pulp industry of Jan. 1, 1952, was almost $18^1/_2$ million tons. Projects now "in process" or "definitely planned," when completed, will raise this annual capacity to a minimum of 21,000,000 tons. Additional projects currently "under consideration," *if* completed, would raise annual United States wood pulp capacity by 1955 to $22^1/_3$ million tons, or 20% above the Jan. 1, 1952, level. This scheduled postwar expansion of 9 to $10^1/_4$ million tons is largely concentrated in sulphate, semichemical, and dissolving pulps. Increases in sulphate capacity from Jan. 1, 1952, to Jan. 1, 1955, will range from 17 to 27%, and increases in semichemical capacity from 31 to 35%.

Most of this new productive capacity, apart from the dissolving pulp, will be integrated with new paper or paperboard facilities. Some of the new integrated plants, however, will have surplus pulp for sale.

This expansion of wood pulp facilities should enable the industry to accommodate any foreseeable growth in our national wood pulp requirements over the next few years. It should have the further effect of speeding the trend toward greater self-sufficiency in both total pulp and market pulp on the North American continent —a trend that prospective wood pulp shortages in Europe may ultimately tend to accelerate.

THE CURRENT SUPPLY/DEMAND RELATIONSHIP

These observations about wood pulp supply and requirements, I realize, have been somewhat general in character and have largely ignored the present apparent *imbalance* in pulp and paper markets.

The current oversupply of pulp and paper, in my judgment, is attributable to two factors: (1) The operation of an *inventory* cycle in pulp products, and (2) the operation of an *expansion* cycle in pulp and pulp products.

Since there appears to have been no decline in the consumption of pulp products at the ultimate consumer level, a return to the higher levels of demand justified by ultimate consumption should occur when the current *inventory* cycle has run its course. The sharper the current decline in demand, the sooner the process of inventory liquidation will be completed. If the decline in demand is sharp enough, the liquidation of excessive inventories of paperboard, in my opinion, could be completed by Fall, and the liquidation of excessive inventories of paper by early 1953.

The current *expansion* cycle, however, could have a longer term impact on supply-demand relationships in the pulp and paper industry. This expansion was undertaken with the firm conviction that there would be a correlative long-range growth in the demand for pulp and pulp products. The industry's basic problem, after a dozen years predominantly characterized by supply shortages, now appears to have become one of creating, through product research and market development, a demand for its products adequate to insure on a continuing basis, a profitable utilization of its expanded productive facilities. There is only one feasible solution to this basic problem—namely, to generate a demand for the industry's products that will absorb the growing supply, so that we may continue to produce and sell. Only in this manner can we derive from wood pulp the full measure of social and economic values that are inherent in the product.

Presented at the Annual Meeting of the American Pulp and Paper Mill Superintendents Association, Chicago, Ill., June 17–19, 1952.

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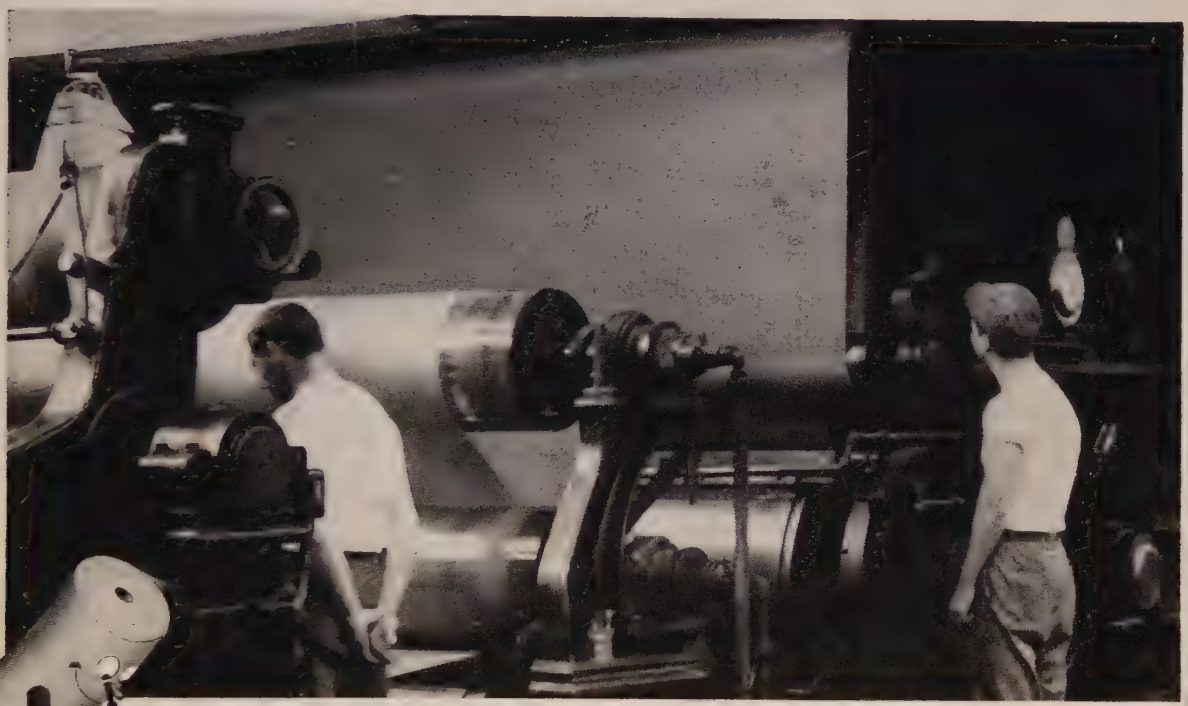

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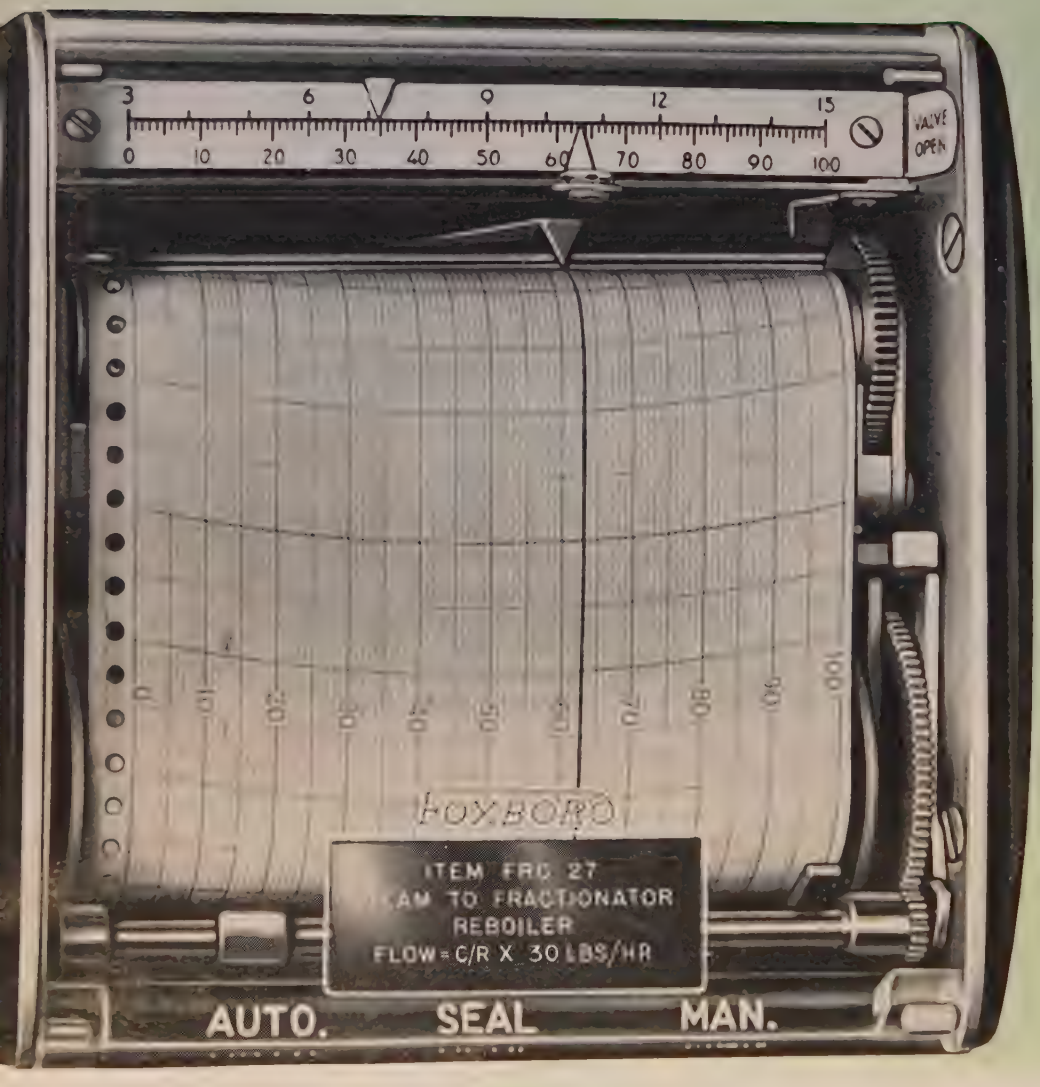

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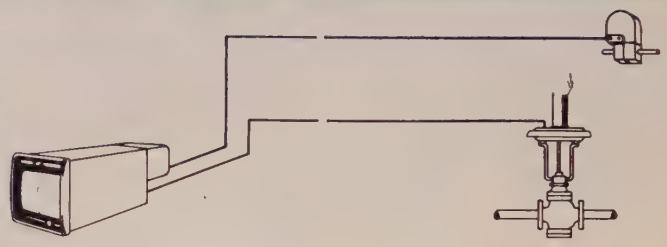

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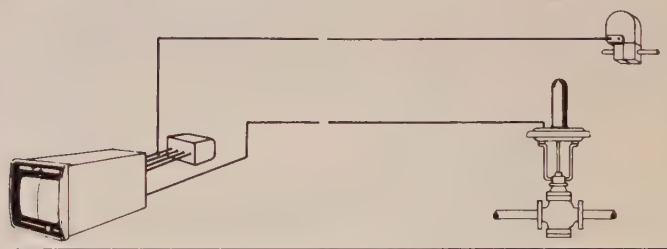
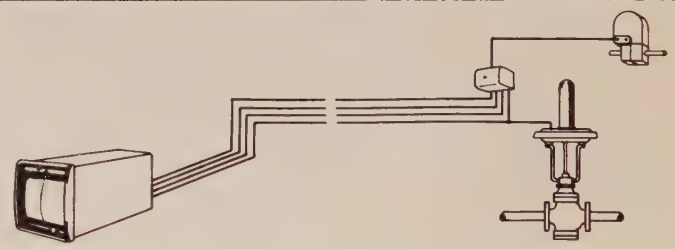


3 Consotrol Recorder with M/58 Consotrol Controller... field-mounted



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FOLDING CARTON FORUM*

Papers Presented at the Meeting Held in Cleveland, Ohio, May 22–23, 1952

The attendance at the meeting exceeded the expectations of the committee as 337 individuals representing 178 firms or organizations were registered. These registrants came from 21 states and Canada.

In connection with the meeting an exhibit of testing equipment was placed on display by 11 firms. Included in this list were Photovolt, Welch Densichron, Vanceometer, Moisture Register Meter, Hart Moisture Meters, the Impact-O-Graph, M.I.T. Folding Tester, Olsen Stiffness Tester, Industrial Nucleonics Beta Gauge, Sutherland Rub Tester, NPIRI Rubometer, and the Martinson Rub Tester. The instruments displayed were examined by many during the period of the meeting.

Morning Session

The meeting was formally opened by F. D. Long, Technical Director of the Container Corp. of America, who served as moderator of the Morning Session.

Manufacturing Board for Folding Cartons

JOHN P. WEIDNER

THE selection of the proper type of board for the manufacture of folding cartons may be approached by outlining the characteristics of the principal grades of folding boxboard. The grades in common use are bleached manila, white patent-coated, and clay-coated boards, including machine clay coated and off machine clay coated. These grades are mentioned in ascending order of quality and cost.

In general, the higher grades have a better appearance which includes a higher brightness and a more pleasing shade, more uniform top coverage, and absence of foreign particles; and have better printability characteristics such as improved smoothness, a minimum of wire and felt marks, a smoother ink lay, freedom from picking, and the ability to produce a higher quality reproduction. The characteristic higher density gives better quality cartons.

As the industry has broadened from cartons made primarily of chip grades, which were not printed, many problems have arisen. The bleached manila grade, first made with bender sufficient to take straight-line gluing, then do the job with ink overscores has graduated to use in packaging heavy materials and bulky materials. A later development has been the package with complicated folds and re-enforced sidewalls. Additional bender has been demanded by the many types of cartons which have closely spaced scores. To realize the extent of the newer demands, think for a moment of the many successful substitutions of clay-coated folding boxboard for litho-lined setup board.

To obtain the bending qualities necessary the board mill has had to obtain new materials for top liner use and new equipment to properly process them. The difficulty has been to produce these properties while maintaining printing quality.

In addition to the successive problems mentioned above, all the grades must be satisfactory for lithographic, letterpress, or gravure reproduction and for flat and gloss ink. Many other surface properties become very important for specific uses on various types of packaging equipment to insure proper gluing. Other surface treatments are required to prevent surface discoloration from cold or hot waxing, varnishing over white areas, or sterilization, to name a few. Prevention of discoloration or fading is important in regard to shelf life.

General characteristics of the board, such as rigidity or stiffness, tear, and working properties, have become increasingly important, not only for customer satisfaction with the finished cartons, but to insure good production and good quality on the scoring and cutting press, and the glue mchine.

The multiplicity of problems arising from the many box designs and the many packaging machines, together with folding carton users' specifications and quality control procedures, has led to the actuality that many boards must now be tailor-made for a specific customer requirement. This has been a tremendous stride from the time that one grade of board would serve all purposes. The board manufacturer must now do more than wrestle with the problems of the carton manufacturer. To be successful the board mill and the carton plant must work together very closely to be sure that the cartons will perform satisfactorily in the customer's operations.

Adequate specifications and full information on all details concerning the type of printing, type of ink, cutting problems arising from carton style, spacing of scores, size of carton, type of gluing operation, and ultimate customer specifications including type and speed of packaging equipment will aid the mill in furnishing a satisfactory board. On new orders usually the mill will make every effort to obtain as much information as possible, but often very important details, such as special end use or customer requirements, do not reach the mill. On many orders which have been satisfactory, changes in carton design or customer packaging equipment may make demands on the board that will not be adequately met by the quality supplied on past orders. If a sample of board has been found satisfactory for any order, submission of a blank carton or board sample with the order will help a mill to manufacture a board having the necessary characteristics.

Some of the problems that have been a challenge have arisen from the demands of ink developments such as gloss inks, the diene inks, gravure inks, aniline inks, and lithographic inks. The problems are not solved entirely by producing a satisfactory printing surface for these inks since the packaging equipment and the customer may demand heat-resistant or rub-resistant inks which may require special board surface characteristics for adequate results.

The trend to multicolor printing has placed additional demands on boards since higher tack inks must be used to obtain proper trapping. In this case the entire structure of the board must be rebuilt to resist the pulling action of the inks. Higher speed press operation intensifies this requirement.

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*Sponsored by the Research and Technical Committee, Folding Paper Box Association of America, and the Lake Erie Section of the Technical Association of the Pulp and Paper Industry.

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Basic development is needed by the ink manufacturer to meet many of the newer demands. This is a joint problem, and perhaps a threefold approach, by the manufacturer of the board, the printer, and the ink manufacturer, some of these problems could be intelligently approached and changes made which would eliminate the most serious difficulties.

The previous discussion leads almost inevitably to the prime requisite of board for any specific order, namely uniformity of properties within any run and duplication of these characteristics in succeeding orders. If the board is uniform carton equipment and inks can be adjusted to yield satisfactory cartons within limits. Maintenance of board within these limits is our basic problem.

Tolerances that can be adequately measured are weight, caliper, and moisture. Controlling weight is a two-directional problem. Weight must be uniform across the machine and in the machine direction which means uniformity in the run. If the weight varies, the moisture content will vary and, in the same measure, the finish and bender will vary. If the weight is heavy in streaks, wet streaks will occur which will prevent proper drying of the ink and give poor cutting. If the weight is light, the finish will be substandard because the moisture is low, the rougher board will not print properly, and will have a poor bender. Caliper variation may be minor in respect to the weight variation.

Producing board at the correct moisture content, as well as maintaining it uniformly, has become a paramount problem with the necessity of increased bending qualities, close register control in multicolor printing with several trips through presses, and the necessity of fitting board moisture content to the temperature and humidity conditions of controlled pressrooms. The correct moisture content is usually dependent also on the type of printing process and must be varied to suit the customer. Difficulties arise because temperature and humidity conditions are not controlled in shipment and in storage.

Other physical characteristics which play an important function in use requirements can be measured and controlled such as curl, tear, stiffness, within meaningful limits. Curl can affect production on both the printing press and cutting press and on the glue machine, as well as on the customer's packaging equipment.

Many characteristics which we would like to measure and control, such as printability and bender, are still best evaluated by press operation. Considerable ingenuity has gone into attempts to solve the problem of measuring the various facets of these properties without adequately defining them in terms of measurement.

The importance of producing board free from dust, lint, slitter dust, trim waste, or any material on the sheet that can cause printing troubles is evident to all. Perhaps not nearly as apparent is the necessity of an absolutely clean furnish throughout the sheet. Grit, dirt, cellophane, plastic or materials such as cork, wood, etc., must be held to a minimum to prevent punching through at the calenders or breaking through at score lines at the gluer. The recent trend to windowed cartons and the use of foils for decorative purposes have greatly added to the superintendent's troubles in selecting proper sources of waste which are clean and free from these materials. Carton plants can help by isolating materials of this nature from their cutting room waste.

All of the problems encountered in board manufacturing are emphasized by the application of machine clay coating. Problems such as poor formation, presence of dirt, poor bonding, and others are intensified. The base stock for machine clay coated must be a grade superior in all respects to white patent coated. Customers tend to expect the same high quality as in off machine clay coated.

Since much of the folding board made is used in packaging foods problems of odor are encountered from board, inks, and adhesives. This problem has been accentuated by overwrapping with transparent films which seal the package and prevent natural aeration.

In conclusion mention should be made of various specialty boards. Some are primarily for decorative purposes, such as lining with foil, litho, special finished clays and transparent films, while others serve end-use requirements such as moisture vapor resistance and grease resistance.

Q. How do you make board to reduce discoloration due to waxing?

A. By selection of top liner furnish, for example, various pulps cause greater discoloration than others, and by surface treating the board to prevent excessive penetration of the wax.

Q. Is it possible to eliminate slitter dust in the board manufacturing ahead of the printing operation or ahead of the printing operation in the carton plant and what means have been recommended?

A. The mill could do a conscientious job of preventing slitter dust by correcting poor cutting caused by dull slitters and dull cut-off knives. I also advocate including the inspection of the finished load by the quality control inspector in the regular inspection program.

Michael Zales, a member of the Panel, answered: "Considerable time and money has been spent in our printing operation because of slitter dust and I would recommend that it be eliminated in the board manufacturing process before the material reaches us."

Q. Since most board mill runs average 10 to 15 tons of a particular grade, how can individual specifications be met for all orders, particularly if they are trimming two separate customers at the same time?

A. Most large mills have production planning departments whose prime task is to group orders according to their specification requirements. The control department groups together orders of like caliper, gloss ink treatment, sizing, etc. It is true that, in some cases, it is difficult to do this.

Q. How should board which is to be varnished over an unprinted area be specified?

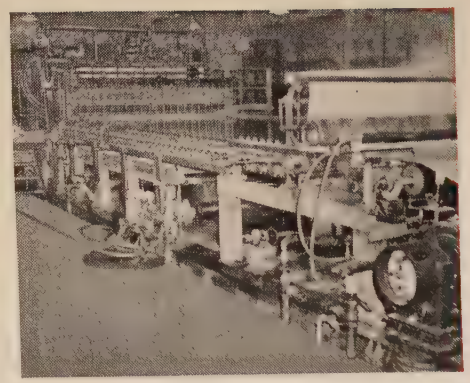
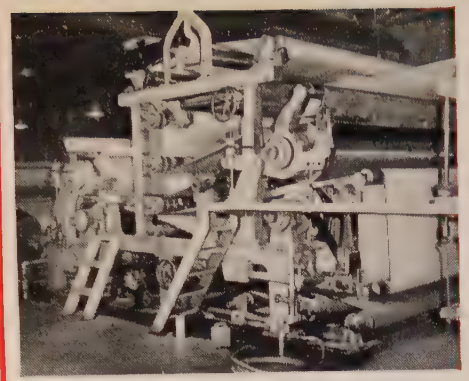
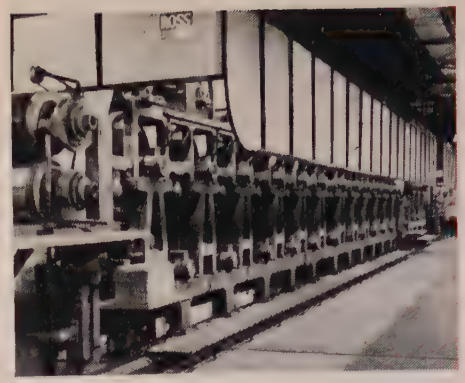
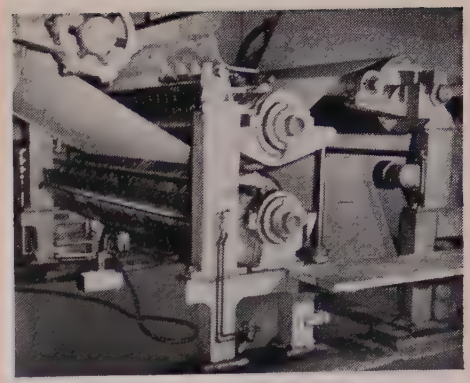
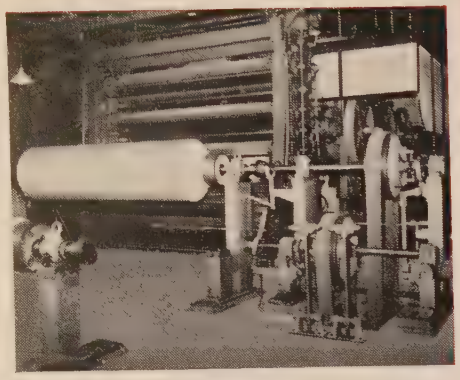
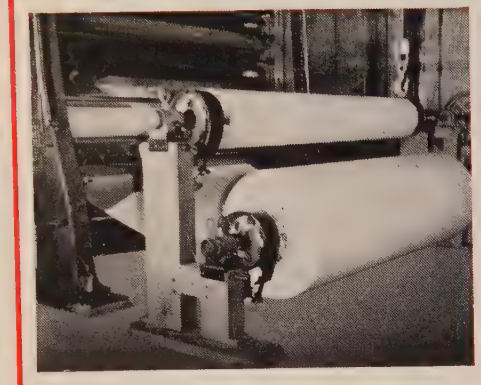
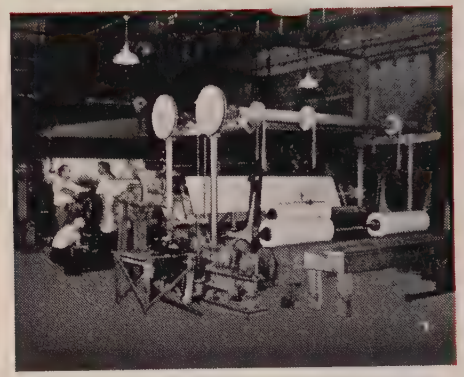
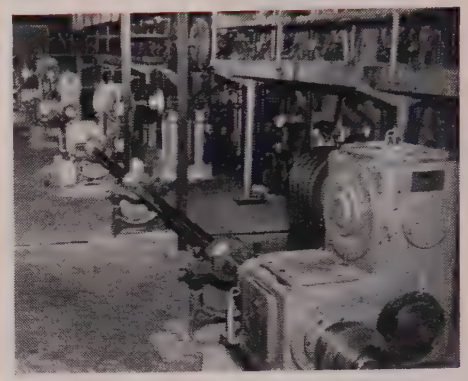
A. Varnish discoloration would be minimized if the board is gloss ink treated and has a rather high brightness.

Q. How much cracking is encountered on machine-coated stock? Is the characteristic dependent on the folding quality of the base stock?

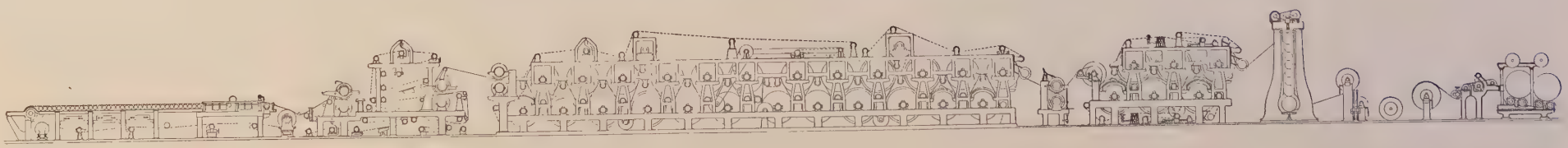
A. Properly manufactured machine-coated board is presently being used for all types of cartons. However, in most cases, the board characteristics including bending qualities have to be much more nearly perfect in machine-coated stocks. Proper selection of make-ready has allowed machine clay-coated board to be used in all types of cartons.

Q. Is the board industry placing proper emphasis on process quality control on repetitious orders?

A. There is a tendency toward laxity on the part of production crews in running repetitious orders. However, in some cases, changes which have occurred in carton design, or in final processing of the board, do not in all cases reach the mill so that proper adjustments can be made. Speaking from an integrated mill standpoint, we do not ship board which is outside of the specification limits. In some cases, the board fails to operate properly because of lack of information on changes in style or processing changes.

Latest Moore & White Fourdrinier machine with 136" wire operating on specialty grades at Hopper Paper Co., Taylorville, Ill. Above views show various machine sections and Moore & White Syco-type machine drive.



The MOORE & WHITE Company 15TH STREET AND LEHIGH AVENUE PHILADELPHIA 32 PA. • CUSTOM-BUILT MACHINES FOR PAPER MAKERS

Q. What mesh cylinder wires do you recommend for the manufacture of patent coated and machine coated?

A. It is not possible to give a universal recommendation. However, 50 and 60-mesh wires on top liner cylinders are used at Manayunk on both patent coated and machine coated. Any coarser mesh will result in wire marks which show up in the finished board.

Q. What deviation in moisture content can occur in transit?

A. Moisture content changes occurring in loads are slight in a 12-hr. period. However, problems may occur with wavy edges and curl on the edges in a very short time depending on the humidity of the storage area. It has been our experience that, in some cases, dangerous overall change in moisture content could occur, either high or low, depending on the humidity of the storage area. Portions of skid loads could be spoiled because of curl in very humid air in a short time.

Q. How far can a sheet be degraded and still give a good result when clay coated?

A. It depends entirely on the end use. For example, whether it needs bending quality or not. It is possible to clay coat many different grades.

Q. Why should a mill have to caliper a sheet lower than standard thickness in order to obtain a desirable finish?

A. Usually it is a matter of simple economics since the mill does not want to furnish the customer overweight and, if the finish is not attainable at the caliper and weight specified, you must let the caliper go down to get the best printing surface.

Folding Carton Manufacturing Problems

F. W. STOWITTS

Folding carton manufacturing problems are not a particularly pleasant but they are an interesting subject. It would be rather difficult to talk on the problems without furnishing a solution. However, recognition of these problems leads to ways and means of correction.

I feel that we should start at the beginning or the origin of the carton. This would begin with the carton user's need for a specific purpose. An agency would be called in and furnished with the necessary copy, and trouble may begin for the carton maker from here on.

CARTON DESIGN

The artist's sketch is very important in obtaining satisfactory final result. This sketch may or may not result in a carton which would be suitable for printing.

The difficulties which may arise would be: colors which are difficult to match, colors may be difficult to make fast to light, too many colors printing one over the other, and too much color.

The size of the carton is important to the carton manufacturer as it should be a fit for the paper machine so that there will be no waste. Very often the size specified by the customer can be altered slightly to give the same cubical content without materially changing the appearance of the carton. If the layout of the carton does not properly fit the die, this should be taken into consideration and alterations made.

In some cases, the engravings are made of zinc rather than copper which is needed for fine screen work and process which results in an unsatisfactory job. An engraver's proof of one set of plates does not give the same results as printing a large form with a much greater volume of ink. Perhaps the screen is 85 line when it should be 100 or 110. Or it is 110 when it should be 85.

Very often there is too much or too little overlap on the glue lap and flaps. In some cases, the layout of the carton places the top and bottom flaps in the wrong position for the sealing machines. In other words, a vast amount of trouble for the carton maker is incurred in the design and making of the original plates.

ELECTROS

Bad electros may ruin a carton and being one step away from the originals print heavier. The electros may not register one with the other because of improper workmanship in the electrotype foundry and they may also vary or be uneven in thickness. The copper or nickel shells may be too thin or porous resulting in a short life of the electrotypes. Screens and edges may come up harsh and very difficult to make-ready.

BOXBOARD

In the case of the boxboard considerable trouble can be caused by unsatisfactory board such as, variation in caliper, board too wet resulting in shrunken sheets while in process causing off register, and inks that will not dry properly. Too dry boxboard results in stretched sheets also resulting in off register, poor bending, and cracked scores. Poor bender in the board, of course, is the source of very serious difficulty. There are many other problems relating to the manufacture of boxboard, such as, poor sizing, oversizing, lack of stiffness, whiteness not up to standard, weight per thousand square feet being incorrect, burst test too low, problem of matching color in boxboard to a printed sheet, oil, or water color.

INKS

The inks are certainly a prolific source of trouble: Poor trap gives you a blurry effect because of improper tackiness of the inks, one printing over the other; drying too hard in the case where several colors print one over the other on succeeding presses, resulting in inks rubbing off or chalking; inks not drying properly, which causes one ink to flow into the other and, of course, a smearing in the handling of the cartons and succeeding processes.

The following are some of the ink difficulties: opaque inks when they should be transparent—in which you lose the ability to make a third color by a combination of two or more colors; transparent when they should be opaque; not fast to light which would cause fading on exposure to light on the shelves or in the windows.

Gloss inks may not gloss due to improperly sized board or poorly formulated inks.

Varnish may not shine because of insufficient sizing of boxboard or poor varnish..

Objectionable odor not alkaliproof for soap and like products, lack of rub resistance, filling up of the screen, weak or lack of color strength, and piling up on the printing plates and many other troubles may result from printing inks.

PRINTING PRESSES

Printing presses get out of adjustment causing a variation in register. Cylinders may not be in proper contact with bearers which would cause a jumping on the impression.

Rollers may be too hard or too soft resulting in improper distribution of the ink.

Pressmen may have made-ready with too much squeeze or not enough for proper printing.

Careless handling of printed loads may cause smearing. Too many sheets on a load sticking and offset.

DIE MAKING AND CUTTING PROCESS

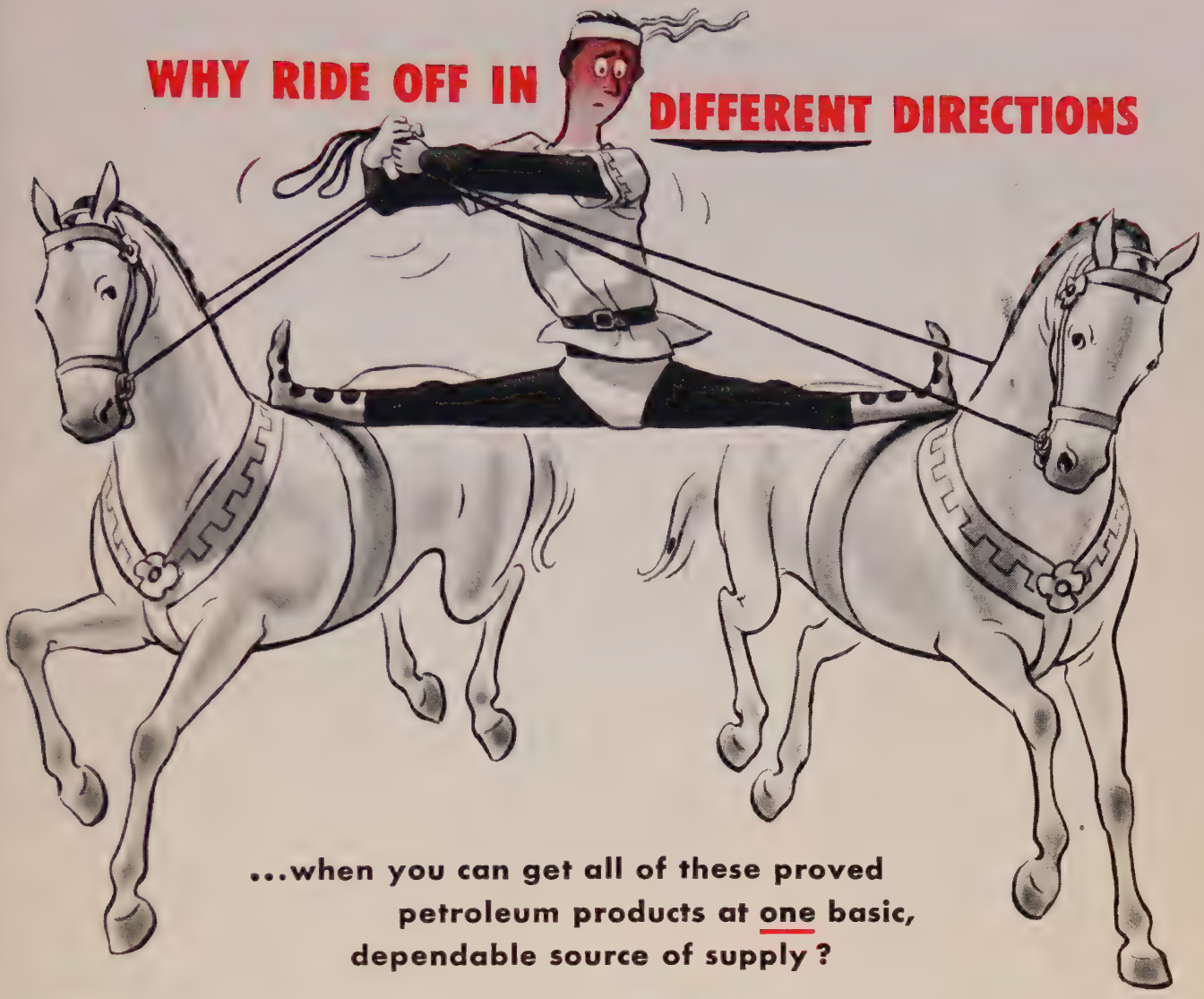
The cutting process has its difficulties, too, such as improper knife or crease for the caliper stock; poor bender which will, of course, result in cracked scores or in scores which are too wide so that the cartons will not fold up squarely.

Improper register of the printing plates to the die.

Wrong counter stock on the jacket either too thick or too thin for the caliper of the board. Scores close together run-

F. W. Stowitts, Michigan Carton Co., Battle Creek, Mich

WHY RIDE OFF IN DIFFERENT DIRECTIONS



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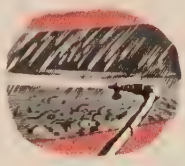

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Process Products

Process Products

W. D. Hall, Folding Box Assn., and F. D. Long, Container Corp. of America, Chairman, Research and Technical Committee of the Folding Box Assn. and Chairman TAPPI Corrugated Containers Committee

ning around the cylinder so that the impression strikes all the folding scores at once placing a tremendous strain on the board. This is very often the cause of cracking where there is solid printing over the scores.

Scores may be too wide or too narrow.

Nicks which hold the sheet together too large. Knives not cutting properly. Dies not locked up tight enough or off square.

GLUING

There are very many problems connected with the gluing operation. Some cartons are so designed that there is a very narrow folding score with long panels which make it very difficult if not impossible to glue cartons up squarely. It is also possible to set up a glue machine so that the carton will not fold up squarely by bringing together the sides of the carton too rapidly.

Too much squeeze makes the carton hard to open. Not removing cartons from under squeeze belt when machine is stopped for adjustment leaving some of the cartons out from under the squeeze which will be improperly glued.

A very common complaint from the customer is due to the flap knives not being cut entirely through and these flaps not being cracked by the stripper or glue machine feeder which results in serious loss of production and product for the carton user. Too much glue squeezed out on the inside of the carton so that the carton does not open readily. Too little glue causing cartons to pop open. Glue not in a proper location on glue lap.

Mixup of various copies of cartons which are very often the same size and run in the same combination.

Torn cartons caused by improper setup of glue machine.

PACKING

The packing operation also has its difficulties in that the cases or folders are sometimes too large and sometimes too small. This can also be caused by a variation in the caliper of the board. If the cases are too large, there is a liability of crushing in shipment. If they are too small, quite often the cartons are torn when they are forced in and they bulge out making an unsatisfactory package.

Often the cartons are improperly labeled and turned in a bundle of 50.

LOADING

Most carton makers receive numerous complaints about improper loading of cars where more than one style or copy is loaded in the car. Insufficient bracing so that with rough handling the cartons become badly damaged. Wrong cartons in the car. Breaking bundles and cars loaded too heavy, and improper count.

I am sure that there are many other causes of folding carton making problems. Problems which may be brought out in a discussion period.

SUMMARY

Our experience has been that our problems of importance are listed as follows:

1. Original engravings and printing plates. This is very difficult of correction, especially in case of rush delivery.
2. Printing inks which are much easier to adjust.
3. Boxboard.
4. Poor workmanship.
5. Condition of equipment last.

The problems of carton making have multiplied tremendously in the last few years and are very closely connected with the requirements and demands of our customers.

With quality control gaining headway in a great many plants there are new problems arising every day.

Customers are installing faster sealing units which they expect to operate as near 100% as possible which means that the cartons must be as near 100% as possible.

I believe a good illustration of problems of carton making is indicated in the following experience.

The speaker has made a statement many times that he has never yet seen a perfect carton and several years ago a new inspector was placed in our carton department and was asked to send to the speaker a perfect carton as soon as possible. This seemed to be a joke and easy of fulfillment at that time. Up to the present time, the perfect carton has not been received, although it has been requested several times.

Q. Is top management willing to invest in development work and personnel training at a time like this? What is the economic return?

A. Top management feels that the present time is the best time for investment in development work and personnel training. Demands from customers are greater and management feels that it needs all of the ability and advice that development work and training can provide. An example of a mistake made by management was the period from World War I to the '30s when management did not elect to invest in development work and, therefore, fell behind.

Q. Has any means been worked out for overcoming cracked scores at the gluers resulting from board that is too dry?

A. Wrong counter stock on the jacket either too thick or too thin for the caliper of the board often is the cause of cracking. Scores close together running around the cylinder so that the impression strikes all the folding scores at once placing a tremendous strain on the board.

Q. Is it possible by finding the moisture content of a lot of boxboard to predetermine the relative humidity necessary to hold the dimensional stability to prevent curling or waving?

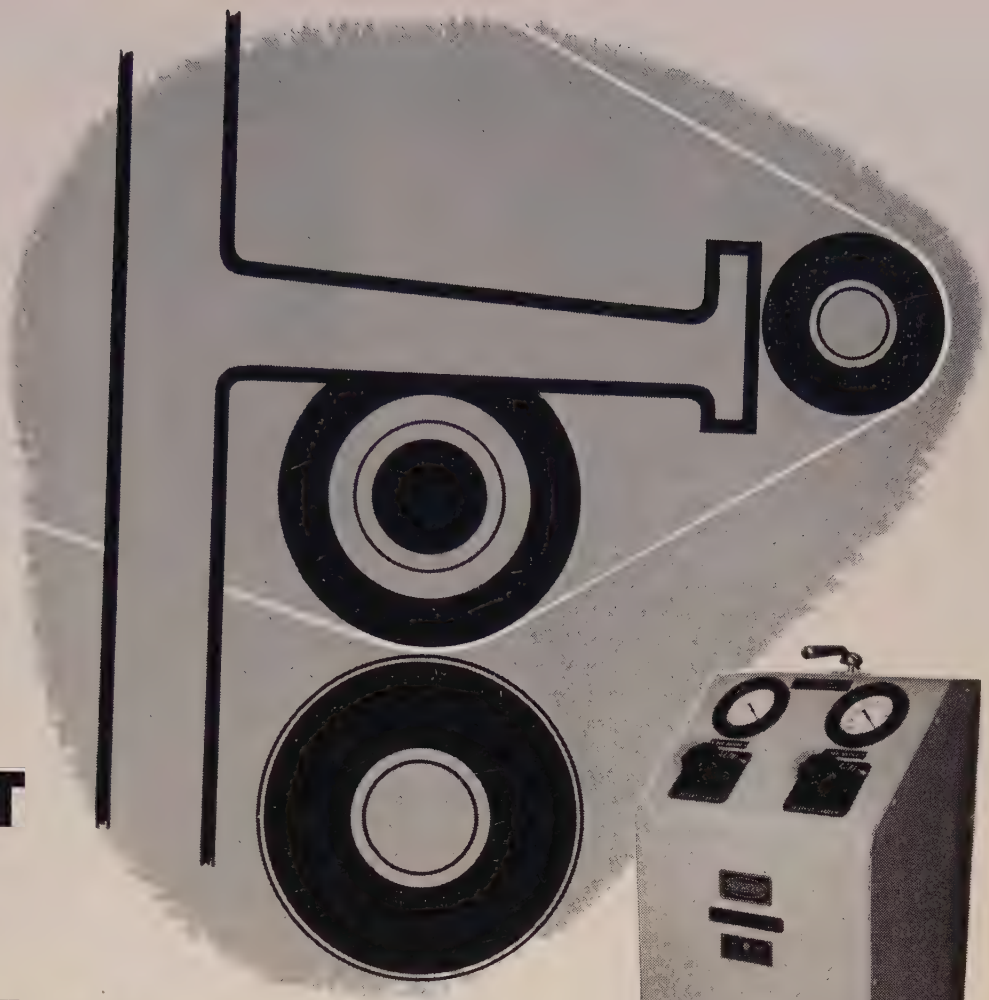
A. Between 45 and 50% relative humidity corresponds to a board moisture content of 5 to 6.5%. Humidity control in the carton department has resulted in lower waste and it has been found that, if board were manufactured in the range 5 to 7%, curl and waves would be minimized. Shrinkage and stretch have proved to be negligible and resulting register control has been considerably improved.

Q. What finish changes have been made in upgrading bleached manilas to meet new strength and folding requirements? What is being done to improve the printing surface when such has been impaired due to the above changes?

A. In order to meet strength and folding requirements, it has been necessary to remove groundwood from bleached manila finishes and replace it with chemical pulps in order to meet the more strict folding requirements called for by higher speed equipment. In so doing, the printing surface approaches that of the patent white sheet which contains predominantly chemical pulp.

Q. How can the effect of gloss ink treatment of board be measured and controlled as it affects gluing quality on high-speed cartoning machines? Is the water drop test reliable for this?

A. The water drop test is not the answer to gloss problems



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since the water drop test is used to measure water resistance rather than oil resistance. However, the water drop test is a reliable test for gluing quality on high-speed carton machines.

Q. How can a customer specify and consistently obtain boxes without cracked score lines?

A. Cracking should not exceed 1/8 in. Solid print over the scores exaggerates score cracking and I believe that customers should allow a small specified amount.

Q. Since there are no perfect cartons, how do you arrive at how poor cartons may be and still be shipped?

A. That is a matter of standards, acceptable to the customer with go and no-go limits.

The following questions were answered by Michael Zales, a member of the Panel:

Q. What is the future of plastics in the manufacture of electrotypes? Can shrinkage be licked?

A. We have tried plastic electrotypes but have found that the plastic electrotype manufacturers are not quite ready to furnish uniform sets of plates. Nonuniformity between plates has caused considerable difficulty with register. The manufacturers of the plastic electrotypes, however, have assured us that they will be able to lick this problem in the near future.

Q. Is there a good practical test which will indicate the suitability of board for printing with glycol base inks?

A. We have no test at the present time which would indicate suitability of board for printing with glycol base inks and recommend that anyone using glycol base inks work closely with the ink man for the best results.

Meeting the Customer's Requirements for Folding Cartons

WALTER SOOY

THE problems in manufacturing paperboard have been outlined by J. P. Weidner and F. H. Stowitts has outlined the problems in folding carton manufacturing. All of these problems can be rightly put into three categories—men, machines, and materials. In my opinion, we are experiencing problems in our industry that should be easily overcome with proper research.

After World War I and continuing into the '30s, most cartons sold for prices that did not yield a profit sufficient to support a sound program in training of personnel, equipment improvements, and research. During these years our industry failed to make the progress that it should have made.

In the past ten years, our industry has been faced with the problems of designing new and better machines, improvements in old machines, and making paperboard with better printing surface. We have also been developing inks that that will stand more severe tests, such as product rub test; inks that are free from odor which would transfer to the product; making inks that will not bleed when coming in contact with soap or detergents; improved gloss inks; and inks that are fast to light.

If we are going to meet customer's requirements, let us first take a look at his specifications. Table I is typical of of the information needed by the paperboard mill in the making of a satisfactory sheet for this type of carton. I believe we all understand that by necessity these specifications may be somewhat different for various cartons depending on the end use of the carton.

Sometimes we have heard a remark that all these technical specifications are not necessary. I know that the majority of you do not agree with this thinking. Specifications that are now in general use in our industry are essential in the manufacturing of a satisfactory carton for our customers.

Table II gives specifications for a carton somewhat different from cartons used for other purposes. For example, the specifications for a food carton would have to be quite different in some respects. Yes, we could go on using a

WALTER SOOY, Gardner Board & Carton Co., Middletown, Ohio

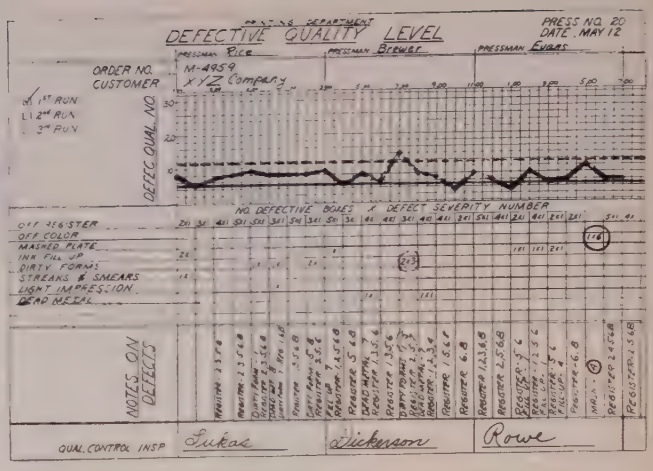

Fig. 1. Printing department control chart

number of examples to illustrate this point, but we would only prove that cartons must be tailor-made.

Since the advent of high-speed filling and sealing machines, operating up to 300 cartons per min., and the modern automatic filling, tucking, and specialty machines, proper specifications have become very necessary in order to maintain good machine operations and keep down the spoilage. You will notice I have used the words "proper specifications." Unless a specification is necessary, I do not think it should be included, and if it is not possible to meet a certain specification, it is not proper.

I have read that the Army specifications for ping-pong balls cover 27 typewritten pages. I hope this is not true.

Table I. Customers' Manufacturing Standards

No. 1 White Patent Coated-News Back for Facial Tissue Cartons

1:	Substance, lb. per 1000 sq. ft. (moisture-free)	85–95
2:	Caliper, in.	0.024–0.026
3:	Bursting strength, lb. per sq. in.	90 (minimum)
4:	Top liner brightness, G.E., no. 1 filter	63–67
5:	Water drop—Top liner, min.	3–20
	Bottom liner, min.	1–5
6:	Tensile, M/D (15 mm.)	60 (minimum)
	C/D (15 mm.)	20 (minimum)
	Glue lap	20 (minimum)
7:	Dirt, Top liner, p.p.m.	40 (maximum)
	Bottom liner, p.p.m.	100 (maximum)
8:	Moisture content, %	5–7

Samples conditioned at 50% R. H., 73°F.

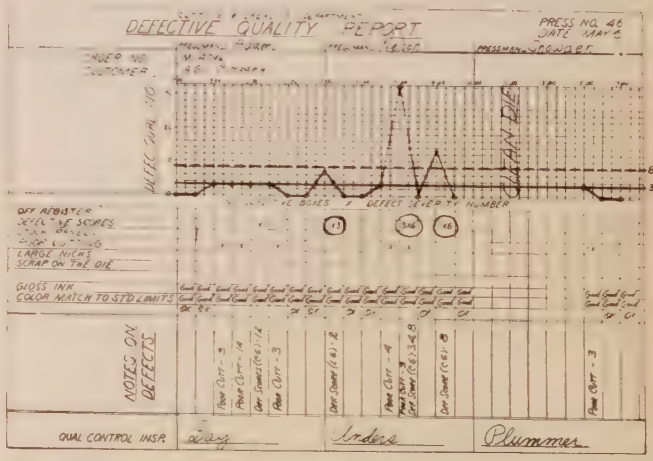

Fig. 2. Cutting and creasing department control chart

America takes it home in Sealright containers

Fine paper products sized better with MERSIZE

Look around the grocery store, the delicatessen, the drug store or dairy bar . . . and notice how many of your favorite foods and beverages are carried home in Sealright containers.

A great tribute to modern Sealright packaging methods, of course. And a great responsibility as well. Containers for perishables must be clean, sanitary, safe—they must *protect* the foods entrusted to them.

What has this to do with Mersize? Only this: Naturally, the paper from which Sealright containers are made is all-important to the product. And, as with any paper, much of the final product's performance depends on the efficiency and uniformity of the sizing agent used. We think it is significant that the Oswego Falls Corporation, and many other mills supplying board for Sealright containers, use Mersize in their sizing operations.

If Mersize has improved their sizing results, chances are it will do the same for you.

MONSANTO CHEMICAL COMPANY, Merrimac Division, Boston 49, Mass.

Sealright, Mersize: Reg. U. S. Pat. Off.

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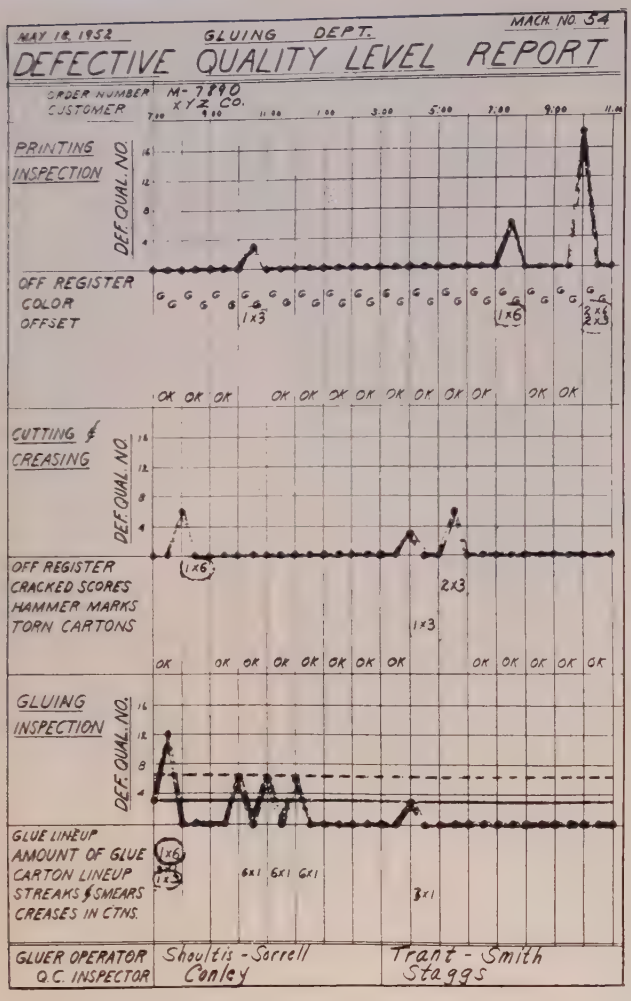

Fig. 3. Gluing department control chart

In order to meet customer's requirements every step in the manufacturing process must be controlled, if men, machines, and materials are going to do the job. I do not know of any better way to keep the operators and management informed about the meeting of job requirements than the use of a good statistical quality control system.

Table II. Manufacturing Standards—Soap Carton Specifications

Engravings	Inks
Text: in accordance with specifications and approved working drawings.	*Gloss:* to give gloss appearance to printed carton surface.
Bleed: as shown on dimensional drawing.	*Rubbing:* ink to resist smear on packing lines and in shipment.
Appearance: sharp, clear, and in register.	*Ink tests:* fade, stability, resistance to heat, match ink color standard.
Printing: sharp, clear, clean, good register between colors and to die.	*Gluing:* Adhesive, mold test, packing and shipping.

My remarks on Figs. 1, 2, and 3 for the printing, cutting and creasing, and gluing or finishing operations will be brief, as I would only be repeating that portion of my talk before the annual meeting of the Folding Paper Box Assn. in Chicago, Ill., last year.

Those who may be interested in this subject, I believe, can secure a printed copy if you will contact the office of the Folding Paper Box Assn. of American, Chicago, Ill.

Quality control will never replace skilled workmen, but it will help them to do a better job. We are always glad to know of research that is being carried on in our industry. A committee of the Folding Paper Box Assn. is now studying the problems of Fadeometer tests, color control, alkaliproof tests, and product rub tests.

Sutherland Paper Co. is manufacturing a very good instrument for testing resistance to rubbing of inks printed on paper or paperboard.

Work is now being carried on by several companies to improve the printability and the opacity of machine-coated paperboard. In the manufacturing of folding cartons there has always been a struggle for quality. Statistical quality control will help your operating men to organize the job so so that quality can be maintained with a minimum of effort.

Q. Shouldn't the industry establish realistic and factual standards for specifications for grades of folding boxboard? As an example, white patent coated and bleached manila don't mean much any more.

A. It is still necessary to have a name to identify the various grades of paperboard. However, it is true that in some cases the grade names are not as realistic as they used to be. There has been a gradual change over the years until now we find most paperboard orders carry specifications which are necessary, because today almost every paper carton that is manufactured is what we might call "tailor-made" in order to meet customers' requirements. With the use of high-speed filling and sealing equipment in our customers' plants, the paperboard must meet certain standards to handle certain types of printing, cutting, and creasing and operate properly on customers' filling and sealing machines. We also find that regardless of grade of board we are running on our paper machine, we have various types of surface treatment. For example, board that is suitable for flat ink printing would not be, in most cases, suitable for gloss ink printing.

Q. Doesn't the use of statistical quality control tend to take the responsibility for good quality away from the production worker? Don't the production workers tend to sit back and wait for the inspectors to find the bad work?

A. It has been our experience that this does not seem to be the case since the control chart shows the name of the operator and the record is posted for each piece of equipment. It has a tendency to make the worker want to have some pride in his work; the man on the next turn coming in can see his record and a spirit of competition is set up. I admit that this is a logical thought and our original thinking had been that there might be this danger. However, actual experience has proved that this particular fear is not founded.

Q. Have you extended your statistical quality control to the manufacture of boxboard?

A. Yes. We started at the end of the paperboard machine and I refer you to my talk before the 1951 Annual Meeting of the Folding Paper Box Assn. This was printed by the Association and copies are still available from the Folding Paper Box Assn.

Q. What is being done to control uniformity of board moisture coming from the driers? How effective are these controls?

A. The Stamm regulator is an example of recent moisture controls and has done much to control moisture leaving the driers. It is impossible to control moisture content absolutely because of caliper variation of 1 point and/or variation in the degree of hydration. A number of things affect the way the web dries. The per cent of moisture recorded on the control chart helps to keep it within control limits.

Q. What methods do you use to acquaint your production personnel with the background necessary to understand control charts?

A. We established a training program for production people where the foremen and operating personnel were given several hours' briefing on the use of control charts and statistical quality control. The procedure at Gardner is to get the men in groups at the end of a shift and give them an hour of instruction in the form of a chalk talk. In all cases, the foreman accompanies the group. A question-and-answer period follows each period of instruction and the training program is continued until the people thoroughly understand the project.

Q. In your statistical quality control program, how do you check up on offset?

A. We do not attempt to check offset with the quality control inspector at end of the press, but do attempt to control it

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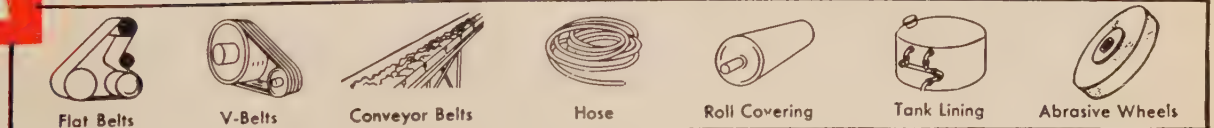

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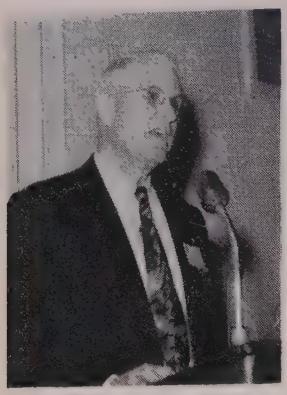

Walter Sooy, Gardner Board & Carton Co.

Michael Zales, Great Lakes Box Co.

by using proper ink films and proper offset spray adjustments. Our experience has been that we do run into considerable offset if we allow our pressmen to attempt to match O.K. colors by increasing the amount of ink feeding from the fountain. In some cases, if extremes in ink films are necessary in order to match color O.K., the ink should be rematched rather than carry a heavy film of ink.

Q. How permanent are inks expected to be in color? What period of time is involved?

A. The Fadeometer is an instrument used to determine the fading properties of inks used in the printing of folding cartons and, in most cases, is determined by the requirements of the customer. For example, in window displays, the Fadeometer requirements would be higher than for folding cartons not apt to be exposed to sunlight for long periods of time.

Q. Who determines the information which is posted to the quality control charts in the pressroom and who posts the record?

A. Girl inspectors who have had a minimum of 80 hr. training inspect representative press sheets and post their information on the quality control charts. In the training program, the inspection girls are shown examples of good and poor scoring and examples of printing, off register, etc. Their judgment cannot exceed their knowledge.

Q. How far away are we from the day when folding manufacturers will send along with the shipment a statistical quality control chart showing the quality level of the lot?

A. The day is coming when the customer will require a quality control chart to accompany his lot. We presently segregate and mark any lots of submarginal quality for our own converting plants and we believe that the customers could also handle the lots better if they know the quality level. The customer deserves to know about the quality level of the material that he is receiving.

Q. Quality control is most difficult on short runs where the job is finished before the samplings are fairly started. Could you expound on this problem and do you think it can be properly handled?

A. Short runs are not handled any differently than any others. In most cases on shorter runs, time intervals between inspections are shortened.

Q. How many quality control inspectors are used per shift? Does inspection cover all three operations? What is the sampling plan at the gluers and are the inspectors members of the quality control department or the carton department?

A. The number of inspectors varies and the number of inspections necessarily would vary with the type of jobs you are running. The quality control inspector has no authority over the production people. However, his inspection does influence the operation of the equipment. The inspectors are female and members of the quality control department and are not attached to the carton department. Inspectors chart their findings and corrections, if any, are up to the plant production people. Inspection does cover all three operations; that, is the paperboard mill, the printing, cutting, and gluing in the carton department. Gluing department sampling plan: four cartons are chosen at random from each of four bundles, also chosen at random. The sampling is done after all gluer inspection is complete and cartons are ready to be placed in containers. Sampling interval is approximately 15 min. on all gluers unless trouble makes extra inspections necessary.

Q. How do you choose your inspectors? Are they men or women? How do you train them?

A. Women are used in the carton department and men in the mill. Those in charge of the quality control department are graduate engineers with a mechanical engineering background. The girl inspectors all have high school educations and are subjected to an 80-hr. training program. We feel that girls are more easily satisfied with a quality control inspection job and that young men may tire of the job in a short time.

Q. How can the quality control inspectors evaluate the quality of the gluing operation if defective gluing is caused by defective cutting or printing?

A. The quality control inspection was shown by the control charts and would evaluate defective cutting or printing which is caught at the gluers. However, this does not in any way affect the quality level of the gluing operation. It is well to remember that the gluing operation is the final look at the product before it goes to the customer.

Q. Have we done as good a job as could be done in educating out customers not to expect photographic reproduction in a normal production run of cartons?

A. (Michael Zales) Sometimes the customer expects to get 110 line jobs on chip. The customer should be educated but it should be a job for the sales department to do so.

Afternoon Session

In the afternoon of Friday, May 23, the discussions were resumed with L. K. Burnett of the Ohio Boxboard Co. as moderator.

Folding Cartons from the Consumer's Viewpoint

W. L. ROMNEY

THE two subjects that I plan to discuss are: (1) carton performance and (2) customer service. I will discuss the subject of carton performance from the standpoint of appearance, machine handling, and product protection. As far as testing is concerned, the emphasis will be on performance tests and not on tests of material. Under the subject of "customer service" I plan to explore the whole idea in an inquiring way from a customer's viewpoint—questions such as: What is the carton supplier doing to serve his customer's future needs? Do you have an understanding of his future needs? What can you contribute as a result of your own research and development to improve his operation? Is your research and development staff adequate to protect your customer's product in the face of some change in your own processes?

Your program committee has been most generous and considerate in selecting for me such a broad subject. This is a gesture which leads me to resist the temptation of throwing the book at you which would be a fate worse than more taxes, and gives me the opportunity to concentrate on some of the aspects of consumer's viewpoint which, I hope, will be of particular interest to this audience.

Phrasing the subject another way, let's try this—"What does the consumer expect of the folding cartons he buys?" Many times he expects a lot more than he can ever hope to get—and, I might add, still at the rock-bottom price.

But with a little more serious purpose in mind, I think he is primarily interested in carton performance and technical service.

I think of carton performance as it concerns: (1) appearance (2) machine handling, and (3) product protection.

What does he expect of appearance and why is it important to him? Perhaps we can throw this into better perspective if we ask ourselves the obvious question of why we are in

W. L. ROMNEY, Procter & Gamble, Cincinnati, Ohio.

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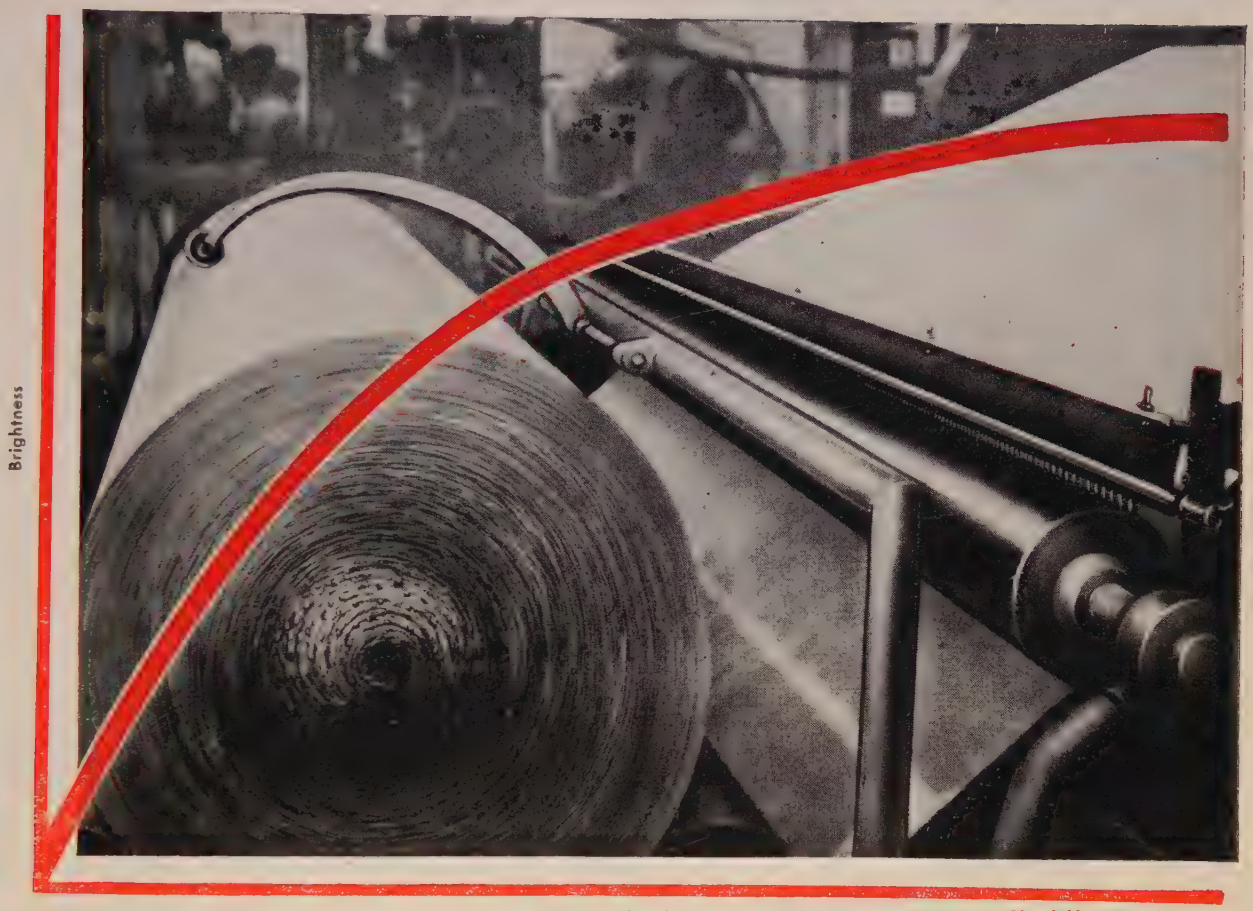

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business and what do we hope to accomplish. Well, most of us are in business to make and sell products that people will buy and by so doing, contribute to the financial success of our business. Whether you sell to industry or the retailer, the principle is the same.

Now, do you suppose people would clamor to select a product if it were packed in a carton with serious ink smear? Our research and experience show that especially in self-service outlets, which today are responsible for a large percentage of the sales, it hurts sales. In the minds of the consumer a good appearing package connotes a quality product, and vice versa.

Each and all of the attributes of appearance, such as uniformity of color for mass display, stability of inks, printing clarity and register for easy identification and reading, rigidity to prevent crushing, and many others, all contribute in a large way to the end result, which is sales and with sales, of course, rests the success or failure of your business.

Then we think of carton performance in terms of machine handling.

Precision—the whole success of efficient machine operation depends on the preciseness of your manufacture. The old days of slow machine speeds are gone forever.

As speeds increase, tolerances decrease—if not, machine efficiencies go to pot. The consequences of this inefficiency go much further than poor costs and discouraged employees, especially if they are working on incentives.

These things alone are bad enough, but our experience has taught us that during times of poor machine operation, the most serious errors in product quality are made.

Thus, it is, that in terms of such things as uniformity of gluing, accuracy of cutting, scoring and prebreaking, squareness of carton and others, the preciseness of manufacture has a profound bearing on the success of a business.

And finally, we think of carton performance in terms of product protection.

My children occasionally prefix a remark to me with this: "Pop, I got news for you"—and then tell me something which may or may not be news to me.

In the same spirit I say—"I've got news for you."

For most manufacturers, the product is the thing—it comes first.

Cartons, as important as they are, are vital, but without a good product, you cannot build a loyal following regardless of how good the carton is.

This is only my way of putting first things first, and this part in no way is the responsibility of the carton manufacturer.

Now, assuming the product is right, what is the responsibility of the carton to keep this product right?

When you ask the question that way, the carton immediately becomes the key to product quality.

Whether the product protection is MVT, grease resistance, strength or what, if the carton fails to perform its function in protecting the product, it is the same as saying we have not only wasted our effort to produce a good product but we are doing a pretty fair job of injuring the position of the business.

In summing up carton performance, I want you to think in terms of your responsibility in *protecting* your customer's interest—the job of adequate control testing and inspection that should be done—the thoroughness of staff work in planning and administering your operations—and above all, keep before you the importance of your customer's product by realizing that: (1) if the carton doesn't protect the product, (2) if the carton doesn't run efficiently on machines, (3) if the carton doesn't display well in the store, (4) if the carton doesn't arrive satisfactorily at its ultimate destination, (5) and if the carton doesn't function properly in use—*your* carton has failed *his* product.

Now, how about technical service?

Well, there are all shades and colors of service that are tabbed with the label of technical service. But, if this service does not go far enough to *anticipate* the user's future requirements and welfare, then it falls short of the technical service mark that a quality user would expect.

Let's ask some questions.

Assuming that you are meeting all your customer's requirements now, what are you doing about his future needs?

Do you *understand* his future needs?

Are changes in your operation involving such things as board, inks, glues, etc., backed up by testing that is sound and complete enough to keep your customer out of trouble?

What can you contribute all by yourself to improve his operation?

Too much of the service we see is of the "putting out the fire" variety.

Until the philosophy of "putting out fires" is replaced by "fire prevention," real technical service cannot even start.

Specifically, I am thinking of a research and development setup, call it customer technical service department or what you will, where actual pilot operations are set up to simulate the carton machine operations of your major sources of carton sales.

I am well aware of the problems and expense involved to institute and maintain such a program, because my company maintains one for the users of our products.

And for that reason, I am also aware that for a thorough study of a technical problem, the customer's equipment, because it is usually available only intermittently, is no substitute for pilot equipment where all aspects of a study are under the carton manufacturer's control.

As a practical example, how could the carton manufacturer, who many years ago recognized the trend toward higher machine speeds, have helped his customer anticipate the difficulties and bottlenecks that he may encounter?

Perhaps some of the most astute may be able to draw on their experience and imagination for the answers, but from the user's standpoint, there could be no substitute for facts as against opinions, and the facts can be ascertained only by actual trial.

There is no better way of getting religion than to have had the actual experience yourself.

As things have turned out, many of the problems of higher speeds have been worked out and others fairly well understood, but the memory of the "trial and error" and "bull it through" methods of acquiring this knowledge, convinces me that there is a better and more painless way of solving such problems.

I offer this pilot operation suggestion, which really isn't a new idea, as a better way.

And the benefits from such an operation are by no means all one-sided.

From the user's standpoint, he has a supplier that understands his business and can be relied upon to protect and benefit this business.

From his own standpoint, the work that he does for others has its reward in the form of acquiring a better knowledge of his own business.

This combination of accomplishments cannot help but put him in a strong sales position—a position where his technical service is not only sought after but where it is *depended* upon.

Other industries have found it pays off—you find it pays off, too.

I doubt if there is a carton manufacturer who hasn't had numerous experiences where he felt inadequate to give the kind of real technical aid that pays dividends for his customer.

Speaking as a customer, I can tell you that when a real job of technical service is done, it produces the same feeling of confidence and loyalty that you have for the surgeon that performed a skillful emergency operation on your child and saved his life.

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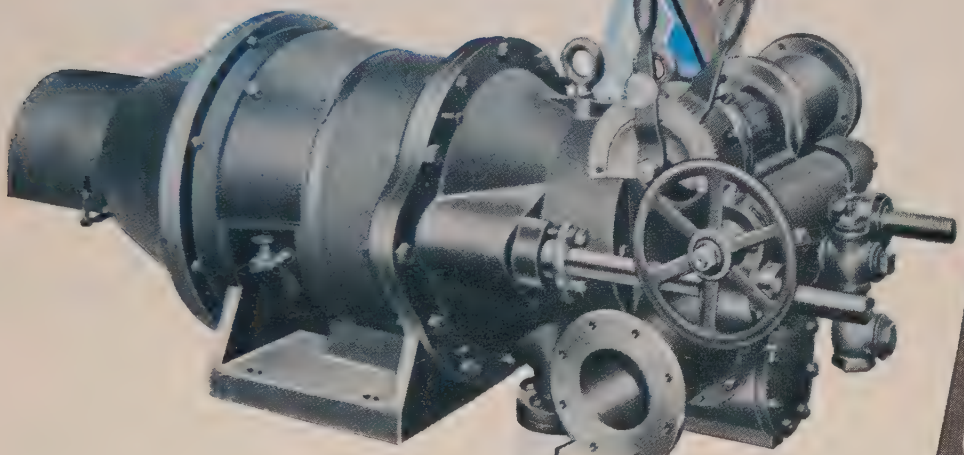

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That analogy might be a bit extreme, but the spirit is the same.

No doubt many of you can think of dozens of worthy projects of exploration that would undoubtedly benefit both you and your customers.

The few I will mention are given only in the sense of examples and not as a complete list.

For instance, in anticipating a trend of higher speeds, explorations along these lines would seem logical:

1. Basic studies of board manufacture as related to gluing and carton feeding at various levels of speed.
2. Carton manufacturing tolerance requirements to maintain high machine efficiencies in customer's plant.
3. Basic studies of the proper use of heat to improve sealing and accomplish the greatest glue economy.
4. Complete exploration of cutting and scoring methods as related to higher and higher speeds.

Then, recognizing the trend toward mass display and self-service merchandizing, we list:

1. Basic studies of the relationship of board formation to inks, particularly as the characteristics pertain to ink rub, clarity of printing, gloss, and economy.
2. Board characteristics and carton shapes and sizes best suited to withstand crushing and damage in shipment.
3. Development of the best methods of accomplishing and maintaining color uniformity.

And, as I have said before, there are many more.

If you will recognize the trend, then the avenues of exploration practically suggest themselves.

In the time allotted I have tried to list some of the high points that I believe are vital to the quality carton user.

If he is to conduct a successful business, particularly where his competition is keen, he must offer a good quality product at a fair price.

The quality of his product is all tied in with carton appearance and the ability of the carton to protect his product.

His ability to sell it at a fair price depends in considerable measure upon the carton supplier's ability to produce cartons economically and to produce them with the preciseness and quality that will permit the user to operate efficiently.

Like so many things that succeed, teamwork and mutual understanding contribute the lion's share.

If that is a good formula for success, then I say that nothing can stop a progressive relationship between carton supplier and user where mutual understanding exists and willingness to protect each other's welfare prevails.

Q. How is an adhesive for carton use selected and what are the tests available, if any?

A. Most of our work revolves around attempts to make the more economical adhesives perform satisfactorily. In our laboratories, performance tests and stability tests are conducted and from this, two to three good samples are given machine trials. The problem is one of combining cost and desirable machining properties.

Q. Do you and others as consumers recognize that, even with statistical quality control, there is a certain percentage of cartons which will be off quality in some manner and what percentage do you consider allowable?

A. It is dangerous to give any percentages. However, tolerances are expected. Our thinking is tuned to performance as the real test. Our procedure is to sample bundles at random and try on the filling machines to determine their workability. If tolerances are satisfactory, performance will also be satisfactory. No mathematical percentage could be set up to determine this performance quality since it involves so many variables.

Q. Would you estimate the extent to which your industry requires cartons providing moisture vapor and grease resistance and comment on the technical and economic problems involved?

A. I can't speak for the industry but as far as Procter & Gamble is concerned, the carton is not necessary at the present time because we have no product at present that requires MVT protection. However, if MVT protection is needed, Procter & Gamble would go to a wax laminated carton in order to get adequate safety factor. At the present time, Procter & Gamble does not need or use a greaseproof carton. Furthermore I feel that there is real room for improvement in MVT rates of laminated board since we have found that in actual practice, the finished laminated carton is only 25% as efficient as the MVT rate of the board would indicate. We would not be too concerned, within reason, about cost if performance were satisfactory.

Q. How do you determine when a particular style of carton has outlived its usefulness?

A. The housewife normally decides the usefulness of a carton. Also machine development sometimes determines the style of a carton. For example, if a machine development resulting in better speed of filling were developed, a new style may be necessary to allow the equipment to be used.

Testing Procedures for Folding Cartons

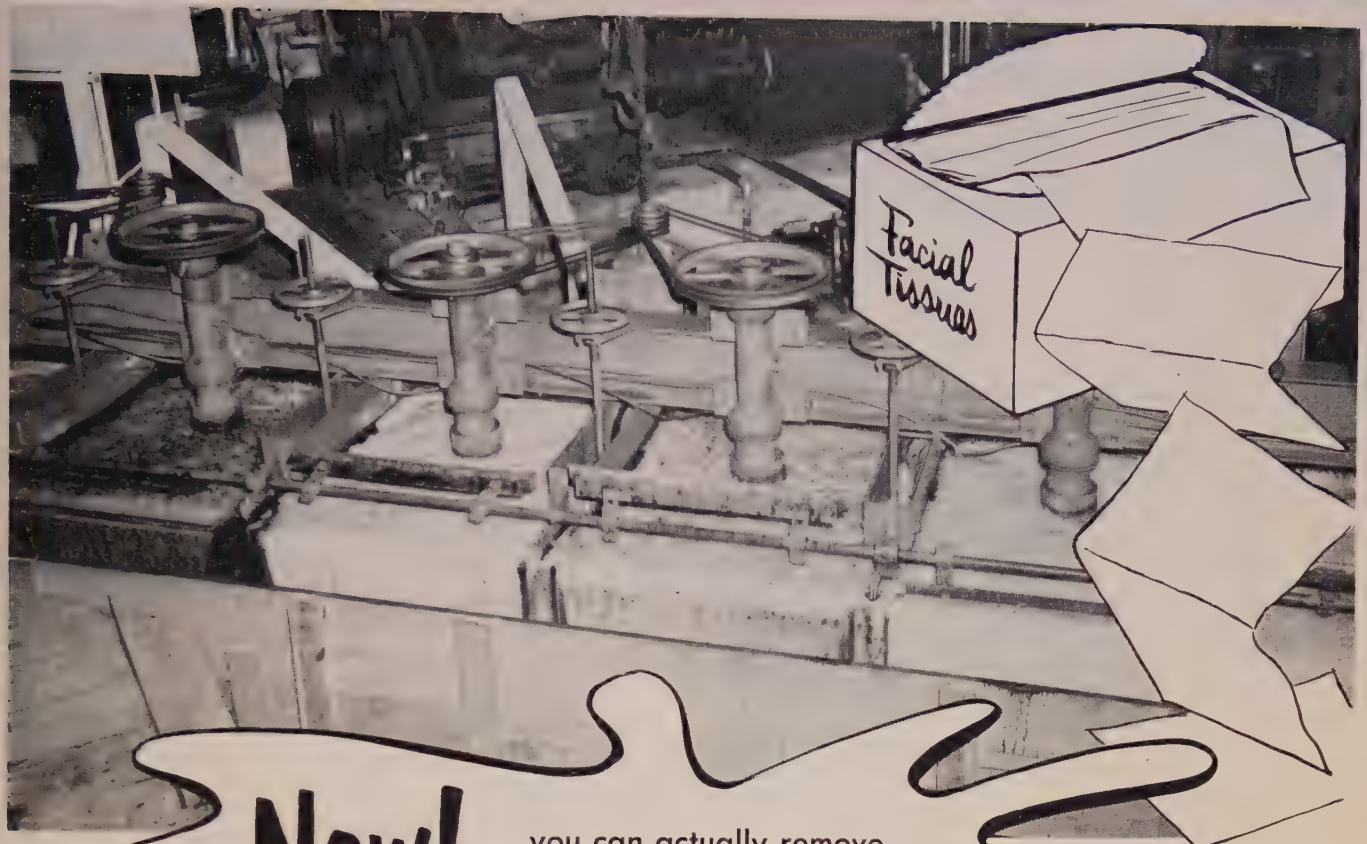
L. R. AYERS

In arranging the program for this meeting, the committee has provided for several related papers followed by a discussion period. I consider this an ideal arrangement, The quantity of material concerning folding cartons which which could be covered is considerable. I feel that the limited time available can best be utilized by a program which emphasizes points of greatest interest. The open forum type of program which we are following should best meet the interests of this group. Also it provides an opportunity for all of us to contribute to our mutual advantage.

The phase which I will specifically discuss concerns testing procedures for folding cartons. While there are a number of approaches to this topic, my remarks will deal largely with certain basic considerations for testing procedures. References will be made to some of the commonly applied tests for folding cartons, but largely to illustrate the basic considerations involved. I believe that this approach will best serve as a background for the discussion period which will follow. Also this approach should prevent us from becoming lost in a myriad of details for individual test procedure. I further suspect that the other papers will present a fairly complete listing of specific tests currently in general use. If I can succeed in stimulating thoughts for the discussion period, I will have accomplished my principal objective.

During recent years conditions related to the manufacture and use for folding cartons have undergone rapid changes. Further, there is every indication that the near future will see an accelerated rate of change. Variety of folding cartons is increasing; production rates for manufacturing folding grades of board, and the converting operations are on the increase. During use, folding cartons are subjected to a greater variety of conditions than formerly. Higher speeds during filling operations are increasingly prevalent. One of

L. R. Ayers, Robert Gair Co., Inc., Piermont, N. Y.



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the results of these changes has been to increase the need for complete detailed specifications for the manufacture and use of folding cartons. Only in this manner can adaquate yardsticks be established for measuring the suitability of the carton in terms of the multitude of specific need. Testing procedures are in effect the yardsticks necessary for making such measurements.

An ideal testing procedure is the result of an instrumentation program carried out to investigate the complete testing problem. Instrumentation in its broadest concept, embraces more than the designing, constructing, and building of the necessary equipment for carrying out a specific test. A complete instrumentation program involves an investigation of the basic fundamental properties. An instrument used for making a test should ideally be designed so as to measure a single property. It is important to not only have an instrument capable of measuring the desired property, but equally important to have a standardized procedure. A background of such fundamental information is of considerable value in interpreting the test results obtained.

Many of the test procedures which are commonly applied at the present time are largely empirical in nature. This is the direct result of the lack of sufficient fundamental background to establish more satisfactory tests. At the present time, the folding carton industry is largely in the state of acquiring the necessary background material for placing their test procedures on a sounder basis. In the interim, empirical test procedures are necessary. This is not meant to imply that empirical test procedures may not prove adequate for many specific purposes. However, the interpretation and interrelationship of such test procedures and the results obtained by using them are much more difficult.

One of the most important basic considerations in connection with testing procedures concerns the reliability of the results obtained. It is almost axiomatic that information which is unreliable may be misleading and actually result in more confusion than would exist if no results were available at all. A number of important considerations enter into the over-all reliability of test results. First, I would like to mention the accuracy of the results obtained. Accuracy is best defined as closeness with which the observed results conform to the true or actual values. Another consideration is the concept of precision. By precision is meant the reproducibility of readings. It is important to recognize that where the material being tested is inherently subject to considerable variation that the test results can vary considerably and yet be accurate. On the other hand, very precise agreement between different test results does not necessarily indicate that the test results obtained are accurate. A correct understanding of the difference between accuracy of test results and precision of test results is important in considering all phases of testing.

In my own opinion no single factor has a greater effect on the reliability of test results than the sampling procedure. I am sure that at times we all have been faced with the problem of evaluating small samples or of considering the test results obtained from small samples. At times, only a single carton may be available for test purposes. It must be recognized that any test results obtained on a sample of limited size or unknown origin can only be representative of the specific specimens tested. The results can only at best be considered a rough approximation of a larger quantity of material.

It is a well-recognized fact that the personal integrity of all people connected with the use of testing procedures must be above question. Naturally a personal element enters into many test results. Frequently where subjective opinions may be required, the personal element may play a considerable factor in the variations encountered. However, the intent to obtain accurate values must be present or the results obtained are worthless.

It is important in comparing test results to make sure that identically the same procedures have been used in obtaining the values. At times, differences in apparently minor details of testing procedures can account for considerable discrepancies in observed results. Every effort should be exerted to establish and maintain rigid testing procedures. Also, it is helpful to have an indication of what is the normal variation in expected results.

Still another factor which must be considered is the variation which may exist between different instruments. By this I do not mean instruments of different design or different manufacture but rather between two presumably identical instruments. Experience has shown that at times the test results obtained on different instruments check very closely, while for other instruments the results may differ by a considerable magnitude. This is a place where the basic design of the instrument and the care with which the instrument was manufactured will play an important part.

There is on display at this meeting several new instruments for the testing of various properties of folding cartons. The mere existence of these instruments is an indication of the work being carried out to revise testing procedures. I believe that an inspection of these instruments will indicate a general improvement over the testing equipment formerly used. Naturally, I am not personally acquainted with all of these instruments, and, in any event, it would not be my intention at the present time to attempt to evaluate these or any other specific instruments. However, I consider it highly significant that an increasing number of new instruments are being offered for evaluating the properties of folding cartons. It is reasonable to expect a general improvement in testing procedures will result from the study and evaluation of new instruments.

Finally in considering the reliability of test results the nature of any changes in the sample being tested cannot be overlooked. This is particularly important in the folding carton field. For example many of the properties of folding cartons will change considerably with their moisture content. Therefore it is necessary for all precise work, as well as desirable where at all possible, to run physical tests under known and controlled conditions of temperature and relative humidity. It is also important to have the samples in the testing atmosphere for a sufficient length of time to insure an equilibrium moisture content between the sample and the surrounding atmosphere.

The natural aging of folding cartons may change their test characteristics. For example, the water receptivity of board is one of the properties affecting sealing characteristics. This property is known to change with time, and is one of several reasons why test results for the degree of sizing of folding grades of board must always show a considerable range Similarly, the bonding characteristics of an adhesive may at times change considerably as the samples age. One of the best examples of the effect of aging is the change in the rub resistance of letterpress ink. Such inks actually dry by an oxidation reaction. This reaction is not completed for a considerable period of time after the actual printing operation. Cartons will exhibit an increase in the rub resistance of inks for days after the actual printing operation. This factor is of negligible importance to the user of folding cartons since the time interval between printing and shipment insures a reasonably standard rub result. On the other hand, the change in rub resistance is of considerable importance to the manufacturer of folding cartons who is endeavoring to closely check his production operation.

At this point I would like to direct my remarks at the purpose of developing and using test procedures. The principal basic purpose is to provide reliable factual data for producing a folding carton of maximum utility and at a practical cost.

At times testing procedures may be applied for research and developmental purposes. In such cases many different types of tests are frequently used for the purpose of studying the

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During the Folding Carton Forum the Ohio Boxboard Co., Great Lakes Box Co., and Dairypak, Inc. were visited

effect of changing some variables or to insure that others remain reasonably constant during an experiment. While such use of testing procedures and the results thus obtained play a part in the gradual improvement of an operation, of more immediate importance is the use of test procedures for evaluating raw materials, for process control, and to judge the suitability of folding cartons in terms of consumer acceptance. Immediately upon considering these latter purposes several factors must be recognized and standards established. What is an acceptable test result? As variation is always present in any operation or product, a single value will not suffice. An acceptance range should be established. The acceptance range must be sufficiently broad to be practical for the manufacturing operation and yet sufficiently narrow to represent an essentially uniform product from the consumer's viewpoint. Very frequently during both the manufacture and use of folding cartons it is more important to hold a property to a minimum of variation than it is to actually hold a particular test level. For example, boards having uniform ink receptivities of different levels may often be printed to give the same final printing quality by using inks of slightly different formulation. However, a lot of board having a wide range of ink receptivity will generally cause considerable processing difficulty and result in cartons having a greater than normal color variation.

The use of test procedures raises many related points. How many determinations are required? How is an adequate representative sample obtained?

The ideal approach to the above problems is through the use of statistical technique. Statistical methods have been adopted by industry by an accelerated rate during and since World War II. They are currently starting to be used in the board and carton field. I am personally confident that the use of statistics in our field will increase. It is reasonable to expect that, in the near future, this trend will play an important part in improving test procedures and in the interpretation of their results. Statistical techniques can readily indicate the reliability of the test results and indicate the magnitude of expected variation in test results.

While the mathematical basis for statistics may be complicated, a working knowledge for considering the results of applying statistical methods, and for that matter the actual application of the methods to a particular set of experimental data, can readily be acquired.

It is always easier to compare and report test data which can be expressed numerically. The use of statistical methods requires numerical results.

As will be readily appreciated from the material previously presented the development of test procedures is best carried out as a group activity. If a proper interpretation of the results obtained is to be had, agreement as to test procedures must be reached between suppliers of raw materials, manufacturers of folding cartons, and the users of folding cartons. Therefore it is customary for the various trade associations to coordinate and standardize testing procedures. Of course individual testing procedures must be satisfactory to the individual companies using them in order to gain general acceptance.

In summarizing my remarks I would like to again stress the ever-changing nature of testing procedures. The improvement in testing instruments and techniques, the extension of testing procedures to properties formally judged solely in a subjective manner, and the wider understanding and proper interpretation of test results can only lead to higher quality folding cartons for all concerned. Properties which cannot be adequately measured can rarely be adequately controlled. Properly applied testing procedures aid the suppliers for the folding carton field; the manufacturers of folding cartons and the users of folding cartons. Testing procedures are in reality tools which can be employed to produce a more satisfactory product. Finally testing procedures provide a means for the manufacturer and the consumer getting together to establish the requirements and specifications for folding cartons to their mutual advantage.

Q. What are the latest developments in testing the scoring quality of board?

A. There is no single property more important or more difficult to measure. In many cases, it is advisable to put samples on cutting and creasing equipment in order to evaluate the folding properties. This is not a completely satisfactory procedure, particularly for the board mill not integrated with a converting operation. However, only marginal materials require such checks.

Mr. Ayers introduced L. S. Campbell of Gair, Canada, who made a few remarks about a Canadian development, the Howard Smith board creaser. Mr. Campbell stated that the Canadian Technical Association has been working on this board creaser and is presently outlining test procedures for the use of this instrument.

L. K. Burnett, the moderator, stated that Ohio Boxboard has such an instrument but has not been able to make satisfactory use of it to date.

Q. How can test procedures be established which will meet with acceptance of both the carton manufacturers and the carton users?

A. A close exchange of information between the manufacturer and the customer should result in a satisfactory test procedure in most cases. The exchange of test results between the customer and the consumer is advocated so that discrepancies in testing procedure can be minimized.

A. (Henry Bond) I do not think it possible to set a routine test procedure since requirements vary considerably from customer to customer.

A. (H. S. Gardner) A test procedure, if good at all, should be subject to review by many segments of the industry, which should include the customer, the American Society for Testing Materials, TAPPI, and other testing organizations and technical groups. Test procedures should not be arrived at solely between the producer and the consumer but should be a joint cooperation of all interests concerned with the particular test.

Q. What test do you recommend for testing the printability of a sheet? What basic test do you recommend on incoming raw material and how many samples do you recommend testing on each incoming order?

A. There is no completely satisfactory test available at the present time other than actually printing the board. In some cases, proof presses have been used. The printability of a given sheet can be broken down into individual component factors which can be checked during manufacture. If the material is uniform, it can generally be satisfactorily converted. In answer to the second part of this question, statistical techniques should play an important part in development of sampling procedures.

A. (Henry Bond) The only test that I know is to put the form on the press and run sheets to see how the material operates. In some cases, Richardson Taylor-Globe uses the K & N ink test and runs some wax tests on certain sheets where picking is a problem.

Q. What test method best indicates gluing qualities on folding board which will later be subjected to high-speed packaging equipment?

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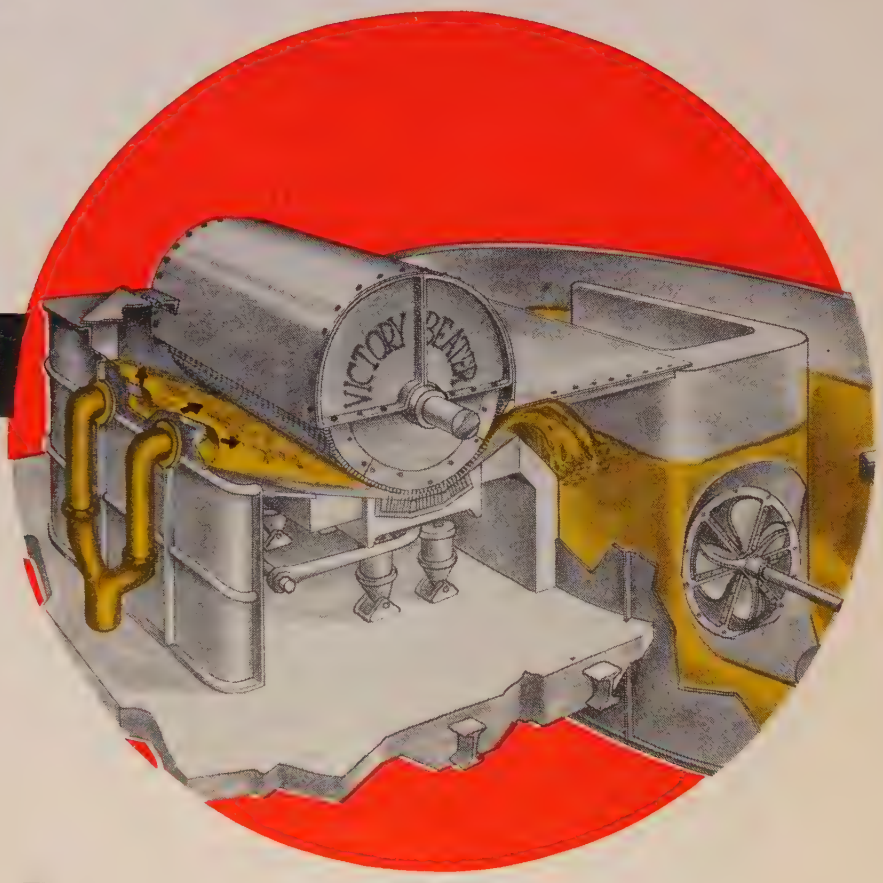

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A. There are several factors, one of which is to attempt to control sizing as a rough indication of sealing characteristics. Water drop tests on the top of the board are a rough indication of sealing characteristics I advocate slack sizing for quick strike-in. However, a uniform water absorption is a necessity. Both filling equipment and adhesives play an important part in performance. If the board surface is uniformly sized, changes can be made in both adhesives and machine adjustment to obtain satisfactory performance.

A. (W. L. Romney) Water drop test on front and back liner. Not to be overlooked is the proper use of heat and adhesives.

Q. Does anyone have an adequate test for ply separation on board as it leaves the paper machine?

A. No, there is no satisfactory test method yet available. I feel separation could be controlled best on the board machine and in the beater room.

Q. What testing techniques do your recommend for the evaluation of printing smoothness of boxboard for control purposes during the board manufacture?

A. Printing smoothness cannot be measured by the conventional tests for smoothness. I advocate the actual printing of the material as being the only presently available satisfactory test. In some cases, there may be danger in using actual proof-press prints made on stock immediately off the board machine since the board on aging may print differently.

Q. How do you test cartons for rub or scuff and how long after printing?

A. Normally 48 hr. is not a sufficient time for maximum rub to develop. However, in some cases, rub tests are conducted on printed material at the end of this period of time. A test made at this time is indicative, however, not necessarily final. Instruments for rub testing are to be evaluated in a project just inaugurated, which is jointly sponsored by a combination of ink manufacturers, carton manufacturers, and consumers. This cooperative project should secure data allowing a better evaluation of existing instruments. At the present time most rub instruments use a reciprocal stroke and are hand driven. This is the type of instrument which we are currently using. I believe that motor-driven rub testers will eventually be in wide use. We check the rub resistance of all proofs prepared, as well as spot check production runs.

Q. In control testing, what portion of the work would you recommend to be done by machine operators?

A. (H. S. Gardner) As much control testing as possible should be kept in the hands of the machine operator since he knows the machine and has to make the necessary adjustments to correct the situation. In my opinion, the quality control department should not be completely separated from production. I believe, that if production people have the time and the proper training, this program should be carried out to the limit of their ability.

A. (W. L. Romney) Machine operators do not do any inspecting. The quality control group under the chemical group tests and furnishes information on performance of test lots. In a mass display, such as is rapidly becoming the case in super market marketing, the user is more interested in noticeable differences rather than small details.

Development of Folding Cartons

HOWARD S. GARDNER

THE development of folding cartons presents an inceasing challenge to the packaging industry. Customers are well aware of the important role played by the carton in containing, protecting, displaying, and promoting the sale of their products. Just as the commodity manufacturer must be always alert to the possibilities of marketing an improved product, so the carton producer must be constantly working toward higher and higher achievement in improved packaging. Development of folding cartons has as its objective the effective use of ideas, methods, and materials so that improved cartons may be made available to the consumer on a production scale. Research, on the other hand, is pointed toward bringing into existence new knowledge, new materials, or new methods that may ultimately have practical application. Research discovers and maps new territory, development brings the results of the discovery to their proper place of usefulness in the general sphere of human activity.

It might be said that development efforts are directed toward the "care and feeding of new ideas" until they have gained sufficient stature to stand on their own merits. In some companies, particularly smaller ones, development activities and attitudes frequently are found in many parts of the company in both sales and production departments. In larger companies development responsibility may be formally organized to some degree, either in an independent development group recognized as such, or as development sections attached to larger sales or production units. Fortunately, the progressive impulse is so widely distributed throughout American industry that there exists an atmosphere basically favorable for development work.

The long path from the birth of an idea to its final realization in millions of commercial cartons can have its beginning in a wide variety of situations. An individual consumer, perhaps exasperated at some failure of the carton to meet his expectations, or possibly having his curiosity aroused by some feature which he has not previously noticed, may create an idea which eventually is presented for consideration to a purchaser or a producer of cartons. A constructive idea may strike the mind of some alert person among the thousands who earn their livelihood producing, filling, or distributing products in cartons. Probably most of the ideas, but not necessarily the most significant, come from those who are actively concerned with the production, sales, or use of cartons, particularly in a supervisory or technical capacity. Who will generate an idea? What form will it take? The answers to these questions defy prediction. The important fact is that ideas come from people, stimulated by a great variety of circumstances and impulses. Recognition of the idea, evaluation of its possibilities, planning and conduct of a practical program to determine its feasibility, and finally the establishment of a production procedure for the manufacture of cartons embodying the concept of the original idea—these form the elements of a successful sequence in development work.

The chemical industry has a well-recognized technique for the development and introduction of new compounds. These usually arise as the result of fundamental chemical research, either in the exploration of a new field or from systematic investigations along a planned course. At first, small quantities are made, often at considerable expense, at the laboratory bench. If preliminary tests of the material show promise, larger quantities are produced in pilot plant or semiworks equipment. Here cost data may be obtained, and other operating characteristics determined with sufficient accuracy to permit design of full-scale plant facilities. Sufficient production may be obtained from the pilot plant to permit a wide distribution of samples to potential users and to provide the basis for a market survey. At the completion of the pilot plant program and the market evaluation, the interested management should have the necessary information available to determine whether or not the program is sufficiently promising to justify the capital investment for a full-scale plant and operations of a large enough magnitude to yield a reasonable profit.

Not all projects graduate from the pilot plant stage. In covering the field a well-conducted research and development program is bound to include investigations of some possibilities that initially seem promising but that later are found to have some serious handicap that causes the project to be abandoned. It has been said that the major question in experimental work is the determination of what is to be studied, and of almost equal importance is the decision as to when work along a particular line should be stopped. Because development work can often begin on a small scale, its initial costs are

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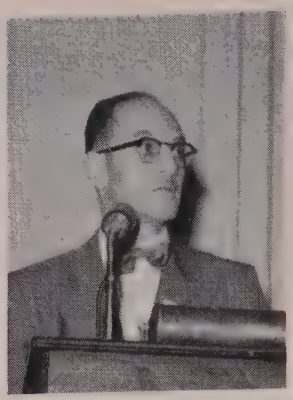

L. K. Burnett, Ohio Boxboard Co.

relatively small, and increasing costs which accompany large-scale development work should not arise until the program has indicated definite promise. Sound development work is one effective way to follow the adage, "Make your mistakes on a small scale, and your profits on a large scale."

Development work covers a wide range of activities. It may be a major project requiring years for its completion, such as the development of a new paper milk carton. Here there are a series of steps involving among them the physical design of the carton blank, determination of the protective surface or coating which is to be developed or applied, manufacturing techniques for the carton, suitable machines for forming and filling the cartons, and possibly a new distributive system as the filled cartons go to the consumer. A program of this magnitude is obviously a team effort with many specialists making their particular contributions as problems become apparent or difficulties arise. On the other hand, development work may involve only a single change in mechanical features, such as an end lock or a new approach to color separation that reduces the number of printing colors required for a particular design.

Development projects may receive their initiating impulse in several ways. The problem may arise from the recognition of a need or of a field which a carton might be expected to fill. Recognition of the need is important, but of almost equal importance is the subsequent definition or description of the need in such terms that it may be understood by others and eventually communicated to someone who is in a position to do something about it. Sales promotional work, trouble shooting, and complaint investigation are all firing-line activities that may serve to uncover needs for carton improvement. Frequently the recognition of the need for improvement on the part of someone experienced in the carton industry stimulates an idea as to the means by which the improvement can be made. At the other end of the scale, a development program may have its inception, not in the recognition of a need, but in the generation of an idea. This idea may be the outgrowth of a research investigation, where certain fundamental knowledge not previously available has been gained, and the research man, or someone learning of the research results, may conceive an idea of how the information may be put to practical use. New materials developed by others, new techniques or methods, new machines or processes in other fields—each has the possibility of generating an idea leading to the application of that which has not previously been applied to the carton field.

The development program begins its activity, then, with a constructive idea to exploit, or with the presentation of a recognized need for satisfaction. In the latter case, the first step toward meeting the need is the generation of an idea bearing on the solution of the problem presented by the need. It has been suggested that one way to generate ideas is to get together a number of people having an interest in the problem and then set them to pounding their heads up and down on a table in unison. There are many ways to promote ideas, more than there is time to do justice to today. However, once an idea has come into being, the important thing is to catch it and look at it carefully, hopefully, and yet critically. If it is a good idea, it should be labeled as such, cherished, defended, and brought to realization.

If no good idea can be raised by any of the orthodox or unorthodox procedures that can be tried, the problem begins to look like a fit subject for research. Serious discussion of research activities is outside the scope of this paper, but it may suffice to point out that when one is faced with a problem for which no practical solution is available, the sensible approach is to study the various aspects of the problem with the hope that a greater understanding of the facts bearing on the situation will eventually lead to an idea that will provide a solution. We keep coming back to the constructive idea as the most important element in development work, and research is one of the sources from which ideas should come to provide the basis for development activity.

Sometimes there may be several ideas presented for the possible solution of a particular problem. Choices between alternatives are often difficult, and it may be necessary to turn to research to develop the basic information which may be necessary to intelligently select the best approach to the right answer. On the other hand, it may be more expedient to settle the question by giving several alternatives each a trial in the early stages of the development program. Here we might base the decision not on technical understanding of the details of the situation, but on a practical comparison of the desirability of the results achieved by the two methods. Scientific elegance of investigation should yield to "quick and dirty" methods or trial-and-error solutions if these can give answers adequate for the purpose in shorter time or at less expense.

Regardless of the nature of the development work, there are certain fundamental principles which ought to be followed if the program is to be successful. Before work is begun, there should be a clear statement and understanding of the objective to be achieved. Many different groups have an interest in development programs: the production group which will have to make the new carton in quantity, the sales organization which will have to introduce it and foster it in a competitive field, top management which if financing the program and incurring development costs with the hope of eventual profits, and the carton purchaser who may be anxiously waiting for the carton in order to improve the position of his own product through the packaging improvement which is anticipated. Research may at times be able to do its work in the atmosphere of an ivory tower, but development programs of importance sometimes seem to have about as much privacy as the well-known fish bowl. Realistically, this is good, for the success of the project depends on its ability to satisfy those who will ultimately live with it both within and outside the company. Constant liaison, beginning with a clear understanding of objectives, and continuing through mutual exchanges of suggestions, information, and criticism, is essential if development results are to end up in the desired form.

Careful planning is indispensable, once the basic idea has been established and the objective has been defined. Development work involves primarily the "scaling up" of an operation from an individual test unit to full production quantities. Questions that must be answered at various phases of the planning stage include:

What shall be the size of the initial experiments?
How rapidly shall we increase the scale of our test runs, assuming that the program goes successfully?
How shall we evaluate our results?
What equipment is available for the work?
How much interference with production is involved?
Will field trials of the cartons be necessary?

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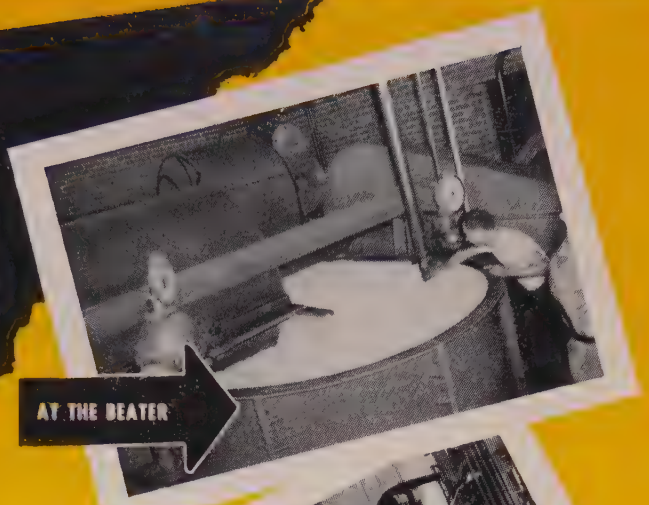

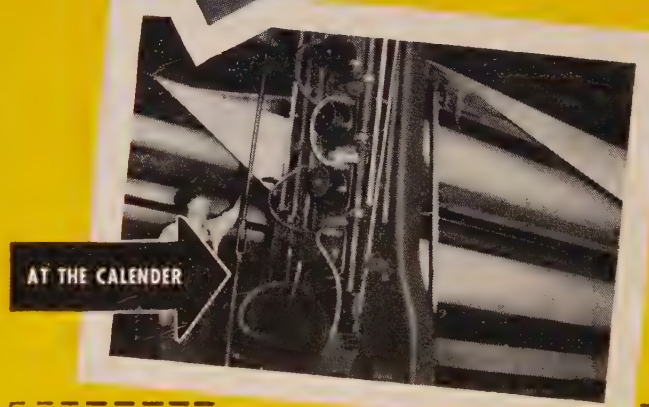

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What special testing methods will be necessary to control quality when the new carton is in production?

Are raw materials contemplated for full-scale production use in this project available in adequate quantities and at stable prices?

Is the patent position of this development clearly defined?

Are estimated costs of production low enough to assure that the carton can be sold against price competition?

Are the costs of the development project reasonable in the light of the potential profits?

Is the project of sufficient importance to justify the time and effort it is receiving—is the game worth the candle?

In addition to technical considerations planning a development program requires the taking into consideration of many diverse factors. It requires a combination of qualities that are needed in a scheduler, expediter, long-range forecaster, and diplomat.

Equipment considerations raise special problems for development work in the carton industry. If existing plant equipment can be used, there are problems of scheduling to permit the experimental program to go forward with minimum interference with production operations. Use of plant equipment is desirable, for it clearly indicates what can be expected on a commercial scale. Frequently, laboratory or pilot plant apparatus is capable of more precise control, or is operated more carefully, than is the case with production equipment. It may be unfortunate when major decisions are based on a small number of very carefully prepared laboratory samples which may represent a level of quality or close tolerance impossible to obtain under plant conditions.

In carrying out a development project good planning provides for making as quickly as possible at least a small run from the initial stage to actual trial of the finished carton. This could be considered as a "vertical" development program from which we get at least a good look at each of the phases which form the sequence of the project. Contrasted with this is "horizontal" development in which each phase of the sequence is studied in detail and brought to a satisfactory state before the next phase of the development is given experimental trial. Vertical development programs have the advantage of providing an opportunity to make a quick evaluation of the end product, and to determine the relative importance of the various phases of the project on the end result. The danger of a horizontal development program lies in the tendency to spend time in getting detailed answers to questions that may later prove to have been of only minor importance, particularly if the project is dropped before completion. Best results seem to come when a program of vertical development goes through rapidly to a perhaps imperfect but still tangible end result, with a return to more detailed experimentation on whatever points the initial test has shown to require further attention.

The ultimate test of a carton is its performance in the customer's packaging line and its service in the field. With the increasing use of automatic packaging machinery, it becomes necessary to recognize that completion of the development program requires test runs under actual conditions in packaging lines. It is impractical for the carton manufacturer to operate a dairy in order to carry out a development program on milk cartons. At the same time, it would be hard to convince any individual dairy operator that his plant would gain by serving as the "guinea pig" for a major carton development program. Most carton purchasers would prefer to receive a trouble-free carton, and would prefer to have the development work done in some competitor's plant. The problem is a very real one for the carton manufacturer has a great reluctance to be the cause of a disturbance in the friendly relations that he enjoys with his customers.

There does not appear to be an easy solution to this problem of ultimate carton testing. A motor car manufacturer can run his engines on test stands and road test a number of new models until he is satisfied that his car is ready to be offered to the public. The carton manufacturer does not normally have the facilities for such thorough testing. In major carton developments, where the simultaneous development of new forming and filling machinery is also involved, the problem of facilities may really be simpler, since the machine under development is normally available for test runs. When the carton is to be used on existing machinery, it may be possible to borrow or lease a typical machine and set it up and run it at the carton plant, if actual filling with large volumes of product is not required. If this is not in order, "dry" runs, without filling, at the commercial packing line may be a possibility, scheduled at times when they do not interfere with production. Another technique is to introduce small quantities of the experimental cartons into the normal run of the forming and filling line. If ten new cartons can go through the line successfully as individuals arranged so that they are scattered through a larger group of regular cartons, it is probably safe to step up the quantity in small doses, by feeding in successive groups of ten consecutive new cartons. If these prove successful a continuous run of the new cartons can be tried. Of course, the carton manufacturer should make every effort to develop his own testing procedures to insure that the new carton will run satisfactorily. However, there is no substitute for the ultimate test on the packaging line, and here the cooperation of an understanding and friendly customer is indispensable.

Evaluation of the results of a new carton development program is frequently difficult. Carton testing, aside from service performance, is pretty much in its infancy. Since paper is inherently a variable rather than a uniform material, no two cartons are exactly alike. Measurement of properties therefore becomes a problem in sampling in order to obtain a quantity of test samples that may be considered representative of the larger lot under consideration. When test data are obtained for a property such as stiffness, there is always a certain amount of variation in the results, and there is the question of how many samples should be run in order to determine the average stiffness within a desired degree of precision. Statistical analysis of the results can frequently aid in determining the proper number of samples to take in a routine control program, or the reliability of conclusions drawn from data that show a certain amount of variation from one sample to another.

To indicate some of the problems in carton development, it might be of interest to describe an experience with milk cartons that occurred several years ago. It was desired to determine the effect of several minor variations in the bottom flap construction of a square milk carton on the tendency of the cartons to develop "leakers" in service. About 14,000 of each of four types of bottom flap variation were made. Before delivery to the dairy, they were marked on the edge with a crayon so that each type of carton could be identified by a careful observer, and then manually arranged in order so that all 56,000 cartons were in ordered sequence of individual types—1, 2, 3, 4, 1, 2, 3, 4, and so on. This arrangement was done so that regardless of the operation of the carton forming and waxing machine, an equal number of each type of carton would receive the same treatment. The cartons were printed for the private brand of a large chain of super markets in a metropolitan city. It was regular practice of the stores to return the small number of leakers to the dairy in order to claim credit. Arrangements were made at the dairy to have the leaker returns from these stores examined daily, identifying each of the four types of bottom construction, and recording the number of leakers that could be attributed to faulty bottom formation of the types in which we were interested. The program ran for 6 weeks, and at its conclusion the number of leakers was so small for each type, varying from 2 to 8 out of 14,000 each, that no significant conclusion was possible with respect to the superiority of any particular type.

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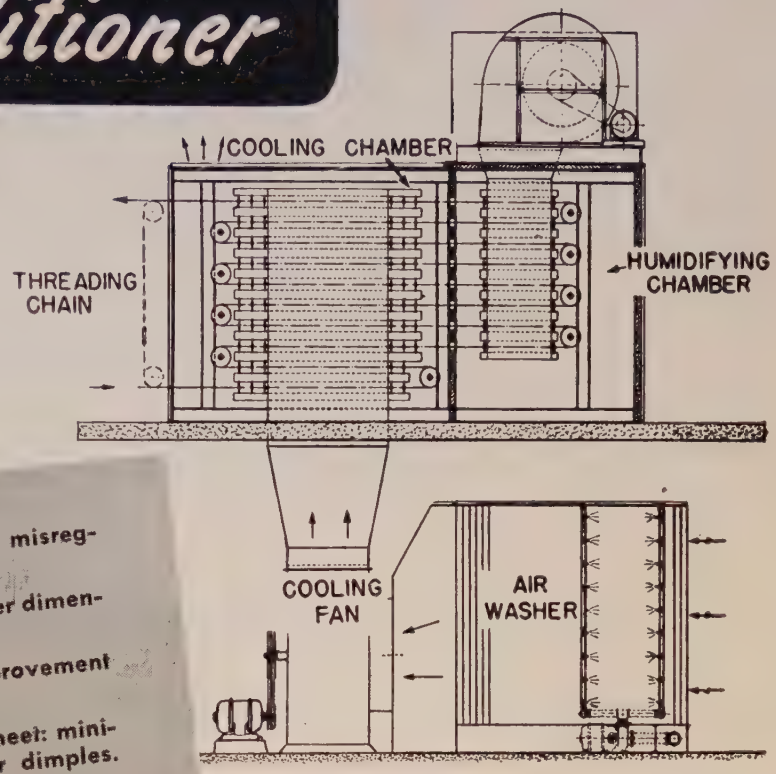

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Wm. Hasselo, Toastmaster of the Evening Session, Chairman, Lake Erie Section of TAPPI, Container Corp. of America

However, after all that work, the results of the test should not be regarded as completely worthless. We had definitely shown that each of the variations was capable of producing good milk cartons, and that it was not worth while to pursue further work along these lines. We had also learned something about techniques in testing milk cartons, and were in a better position to plan more significant experimental work for the future.

The problem of interpreting the results of experiments in a development program has many pitfalls. Frequently, the results do not come up to the expectations of some who have high hopes for the project. It is important to keep in mind that the development program is being conducted in order to test out on a small scale, ideas and procedures which are under consideration for large-scale production. It is far better to be having trouble in a development program than it is to be encountering the same difficulty while trying to produce a new order for a critical and important customer. Negative results are of value in developing a better understanding of the problem, if the failure can be interpreted satisfactorily. Positive results are encouraging, but they need to be confirmed by repeated tests until it is demonstrated that the new development is adequately understood and completely controlled.

When properly understood, development work can play an important part in the folding carton industry. It is not necessary that development programs be highly organized or conducted on a lavish scale. Most of the development work being done in the industry today is probably being done in production and in sales organizations, and it is a healthy sign wherever it occurs. For most effective development it should be recognized as a distinct and separate function in the industry, placing its emphasis on the recognition and evaluation of ideas, and the step-by-step conduct of a planned program to safely carry forward the application of the idea until full-scale production is achieved. The techniques and methods of development workers in other industries: they require full exchange of information with all groups interested in the project, careful planning, competent prosecution of the program, and intelligent interpretation of the results.

However, there is one aspect of carton development which raises a special problem for our industry. It may be pointed out that of all the materials in common use today, paper is used under conditions which subject it to the greatest loads, in proportion to its physical properties. Paper is used with less factor of safety than any other structural material. Because of its reasonable cost, it can be used for disposable packages and in general we ask it to do its job, to make the trip safely—once. Because the properties of paperboard are controllable within reasonable limits, it is possible to produce cartons by the millions that are today doing jobs that yesterday were challenges to the imagination. These represent completed, successful development projects. With continued sound development programs, we can continue to travel the hard road from the bright idea to the brilliant reality.

Q. What caliber of man would you suggest for heading up a customer's service department? Second, carton development department?

A. Obviously try to get as good a man as possible. A customer service man should be a man who can get along with people, able to make a quick sizing up of the situation, and able to sift out the unimportant details. The man should have stick-to-itiveness and should be open-minded so that he would not be discouraged if initial trials fail to give satisfactory results. I do not believe that formal training is of paramount importance as long as the man selected knows cartons and customer conditions. This job is extremely important since the quality of the customer's service is vital to the company as in most cases it could determine future business. A man heading up a carton development department needs particularly to have imagination and ingenuity. He should be able to generate ideas, to stimulate creative thinking in others, to recognize good ideas regardless of their source, and to reduce them to practical application in an economical way.

A. (W. L. Romney) The customer's service man is very important to proper relations and the man should be given proper supervisory status and be allowed to speak for the company when calling on the customer. In the selection of the carton development man, the first quality needed is originality, which is practically immeasurable and would probably be a trial-and-error process of elimination type of selection. Formal training again is not too important but creative ability and ingeniousness should be in his make-up.

Evening Session

Following a dinner, W. Hasselo, Container Corp. of America, acted as toastmaster and introduced the Evening Session speakers.

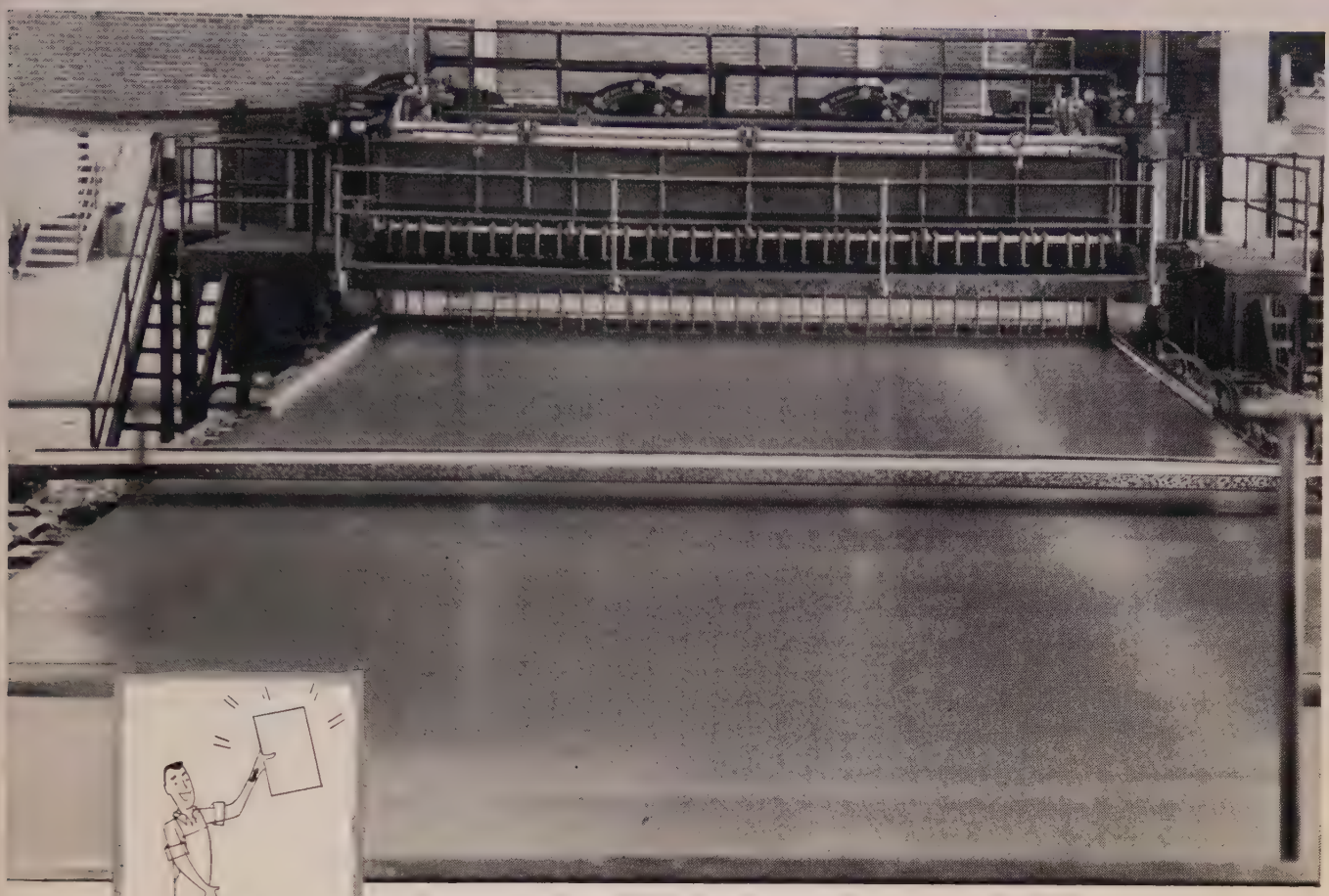
The Future of Folding Paper Cartons

R. A. IRWIN

It would seem likely, due to the fact that you have had a very heavy program today, and that you are now settled down after partaking of various types of nourishment, that your Speakers' Committee did not expect me to discuss my topic of "The Future of Folding Paper Cartons" from a technical viewpoint. You have had the opportunity today of listening to a number of experts on various phases of our industry. While I have been engaged in our industry for some years, most definitely, I am not an expert on the technical problems which confront us. Indeed, if I were to attempt to delve into our common future on this basis, you would be reminded of the story of the two G.I.'s standing at the side of the road. Another soldier went past with a helmet under his arm and a great, gaping hole showing through his head. Apparently, in answer to a question, the one G.I. said to the other: "Naw, he ain't wounded. Haven't you ever seen a Lieutenant with his hat off?" I think it would be very possible that the hole in my head would start to show in any technical discussion.

Again, I think that you should bear in mind that I speak as a Canadian. It is perfectly true that many of our problems are common to yours, but we have some special ones which do not exist in your country. In selling folding cartons in Canada, we have a demand for our products which stems from a population of only slightly more than 14,000,000 people, who live in an area larger than the United States, with a distance of over 3000 miles from east to west—from Halifax to Vancouver. In other words, our potential market, spread over a large area, is less than twice that of the State of Ohio. That, in itself, has a definite bearing on our thinking and our plan-

R. A. Irwin, Sommerville Ltd., London, Ont.



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ning in looking to the future. The very lack of a mass market, such as you have, indicates some difference in future possibilities.

We also have another situation which you do not have in the United States. We are a bilingual country with nearly 35% of our population being French-speaking. This means that much of our packaging is printed in both French and English. Not only does this sometimes complicate our design and plate problems, but, in dealing with our French-Canadian customers, one has to be careful to study exactly what they want. Some years ago, in speaking to the Folding Box Assn. in Chicago, I quoted from a letter which our company received from a Quebec customer, in which he said: "Will you submit to us a sample of a box, folding type, suitable for brassieres, covered with cellophane all over, with a window in front to permit seeing contents." Obviously, there is a very definite possibility of confusion as to just what he wanted.

HISTORICAL DEVELOPMENT

It is customary, in considering the future, to study the past. The whole basis for making future plans has to be determined on past performance. For that reason, I would like to very briefly comment on the rapid changes which have taken place in our industry.

From the very beginning, we have been dependent on a satisfactory raw material, the basic one of which is, of course, paperboard. The birth of the modern use of paper and paperboard, I think, might be placed in the year 1806. To us, that may seem a long time ago, but it does mean that tremendous advancement has been attained in a relatively short period of time. Prior to that year, all paper and boards used were made by the "vat process" by hand. In that year, the two Fourdrinier brothers, with the assistance of the Frenchmen, Robert and Didot, and a brilliant mechanic by the name of Donkin, were successful in operating the first continuous papermaking machine. The history of this group of pioneers is a tragic one, filled with bankruptcies, broken patents, and long legal arguments on the rights of the original inventors. While trying to protect their own interests, they also had to cope with the animosity of the working man, who, on occasion, saw fit to set fire to factories making use of the Fourdriniers' ideas due to their opposition to mechanical equipment.

One rather interesting event took place in those early years which might have given us an indication of the trouble we are having now with the Russians. Apparently, Tsar Alexander of Russia became very much interested in the fourdrinier process, and made arrangements whereby an agreement was reached to have two fourdrinier units installed in Petrograd with the understanding that the Fourdriniers would be paid an annual rental of the tremendous sum of $3000 a year. Machines were shipped, but no payments were forthcoming, and finally Fourdrinier went to Russia to see if some payments could not be made. All he ever got out of the Russians was the same as we get out of Mr. Malik today—a rather rude "No."

It is true that, up to the present time, in some parts of the world, paperboard is still being made on the vat principle by hand. Possibly some of you have seen samples originating in India or in the East. If you haven't, you can rest assured that this type of board doesn't work very satisfactorily in modern-day equipment. From that unhappy beginning, the ability to produce paperboards and fine papers at high speeds rapidly developed. It was nearly 80 years later, however, when an apparent need arose for a satisfactory type of package which could be cheaply produced, and which would adequately protect small units of food and other products. At the beginning of this century, it became apparent that the old-time methods of distribution were in for a very rapid change, and printing equipment was adapted to handle paperboards which were diecut and, in some cases, diecut and glued, to protect common food products, patent medicines, and other products.

While there was a substantial development up to the beginning of the First World War, it was not until the 1920's that high-speed equipment provided the wherewithal to supply industries with a comparatively cheap and satisfactory type of package in the form of folding cartons. The mass market created by the rapidly expanding demand provided by the super-market method of distribution imposed a continuously expanding need for packages that could be produced cheaply and efficiently. The folding carton started to replace setup boxes, metal containers, and glass, where it could be proved that the desired strength could be provided, along with the basic advantages in space-saving and cost. It was only a little more than 15 years ago that specialty boxmaking equipment started to provide some of the answers of improved construction, as produced on angle-fold gluing machines.

During the last World War, it was, of course, necessary to curtail the development of new machines, new processes, and simultaneously, it was impossible to supply the material and labor necessary for fields which, up to 1940, had been barely tapped.

RECENT PROGRESS

In the past seven years, since 1945, we have had the opportunity of witnessing what has been almost a complete revolution in the packaging world. Due to the rapidly increasing cost of labor, the combined efforts of package manufacturers and of package machinery manufacturers have been concentrated toward eliminating or reducing, to as great an extent as possible, the labor element in the cost of properly packing goods. Not only has it been necessary to produce folding cartons cheaply, but it has been necessary for us, as manufacturers, in cooperation with the package machinery people, to reduce the cost of the packaging operations in our customers' plants. The production of precision-made packages has become a necessity throughout our industry. We are all familiar with these changes in our customers' requirements. It is equally true that there have been many changes in our own methods of conversion, some of which will unquestionably have a profound effect on our methods in the years to come.

In order to produce a better product, we have continuously urged the board mills to produce better and better quality in paperboard. Printing plates and electros, made with great precision, have been required, and we have constantly drawn on the many new developments in the ink field in order to secure better color reproduction at higher speeds.

It has been necessary, in order to remain competitive, for us to give far more attention to our cost control. The problem of spoilage becomes increasingly important, as do our methods of handling. We cannot waste either material or labor without a serious effect on our profits.

In the field of printing, we have seen the introduction of high-speed, rotary sheet-fed equipment. The use of web-fed machines, using letterpress, rotogravure, or aniline, usually tied in with a diecutting unit, is becoming commonplace in many of our plants. Some of you had the opportunity of observing some of this equipment in operation. In one plant we observed the type of machines necessary for mass-produced, large volume items. Others, in another plant, had the opportunity of seeing a smaller and highly efficient unit which is adaptable to press runs of moderate size.

In the diecutting field, the high-speed reciprocating press for web cutting and the use of rotary dies for long runs have made very rapid strides during the past two or three years. We have recently witnessed the introduction of European sheet-fed equipment for standard diecutting work, which would appear to have some very interesting possibilities.

In the gluing field, the use of rugged, high-speed gluers, with facilities for 180° breaking of creases, has not only reduced the cost of this operation, but has provided an improved product for the customer. Hand in hand, the newer types of adhesives have greatly assisted in securing better speeds and more

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positive adhesion. The problems in our gluing departments are frequently difficult ones but, as the new carton constructions have been developed, the equipment manufacturers have rapidly come up with reasonably satisfactory answers.

Sometimes we may be inclined to feel that we, on this continent, have a corner on inventive ability. A few months ago, I had the opportunity of spending seven or eight weeks in Europe and Great Britain and, to anyone who has visited carton plants abroad, it is evident that the carton industry in those countries is advancing almost as rapidly as it has here in the United States and Canada. Unlike our methods in America, over 90% of all the cartons produced in Europe are printed by lithography. Some of the newer lithographic equipment manufactured in Europe is, I think, the equal of that being manufactured here, and is producing very fine work at very interesting speeds. They have two or three manufacturers of excellent gluing equipment, though they do, of course, use a substantial number of American-produced machines. I have already mentioned the diecutting equipment produced in Switzerland by the Bobst people, who also produce the Autovariable, which some of you have seen at the Great Lakes plant.

By and large, their carton requirements are similar to our own. They are just beginning to experience the super-market development with its incessant demand for more and more packaged goods but, as far as the packaging of new products is concerned, they have some very interesting developments.

I have a couple of samples here of a package developed in Germany, which is called the "Eco" pack. It is in common use in Northern European countries, requiring specialty filling equipment, but providing a highly satisfactory package. With almost an absolute minimum usage of paperboard, it has proved to be very successful in both the dry powder field and also in the frozen food field. As a matter of fact, I have some samples of this package which were produced by one of my competitors in Candada for a Canadian frozen food account. The package has proved to be highly satisfactory in the Canadian market. In construction, the package consists of a glued sleeve and two diecut ends. Frequently, these ends are punched on a steel die. The sleeve itself is coated with the material necessary for the product to be packed, and the ends are treated with heat-sealing material for an adequate closure.

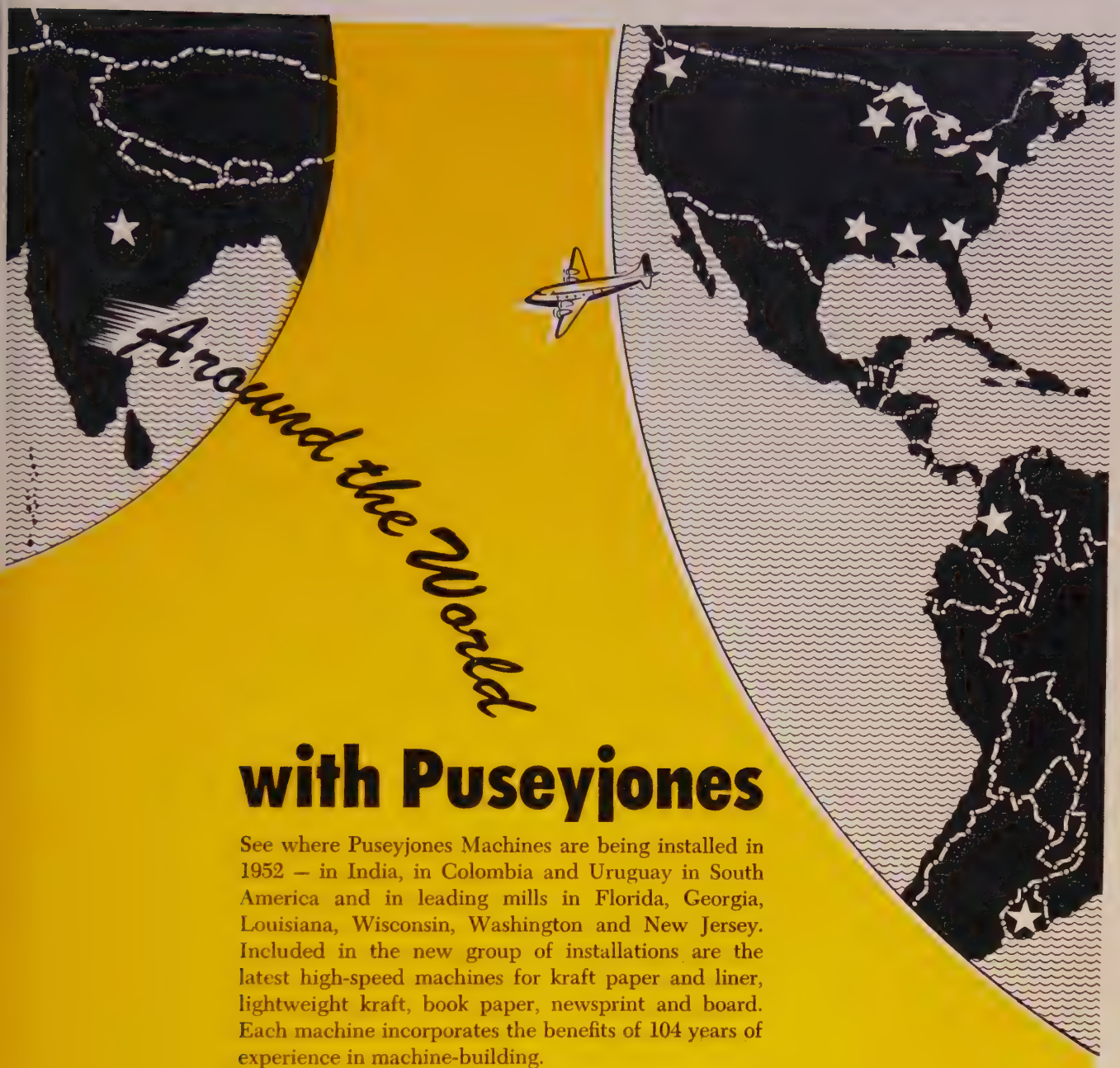
Some of you may have seen the recent press releases on this rather peculiar looking package. Whether it can be called a carton or not, is questionable, but it has been produced in Sweden under the name of "Tetra-Pak" for the packaging of milk and other fluid products. We are all very much aware of the tremendous demand of the dairy industry in this country for paper milk containers. Whether this very unusual shape, though it is highly economical in the use of material and in manufacturing costs, will provide a competitive package against those now commonly in use, is yet to be determined.

I also have here a Swiss development, consisting of a folding carton for glass, medical ampoules. This is another example of a folding carton invading the setup box field. The ampoule compartments are continuously formed, glued to the side, and cut to length. While this is a specialty, in that it cannot be shipped in its knocked-down form, it has substantially reduced the cost of this protective type of pack, and is gaining in use on the Continent and in Britain.

THE FUTURE—ITS POSSIBILITIES

In thinking of the future, some of us may be inclined to feel that the substantial drop in activity in our industry which has

Dinner group at the Folding Carton Forum, May 23, 1952



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now lasted for many months, is an indication that we have attained the goal of maturity, and that the development period of the past few years has spent its force. Some may feel that we are now confronted with a leveling off which may be more or less permanent in nature. In my opinion, nothing could be further from the truth. To hold such a belief would only be admission of our own inability to create and improve. It is a matter of record, both in your country and in my own, that, on the average, our industry has been expanding tonnage-wise at an approximate rate of about 7% per year over the past 25 years. It has always been true that this growth is not a steady and continuous one. Tonnage figures this year will probably show a reduction from those experienced in 1951. Nevertheless, we would be very fainthearted indeed if we believed that we had attained the ultimate in healthy growth.

Over and above the fact that we have prospered and will continue to do so in an expanding economy, with no foreseeable end to the annual increase in our populations, we are perfectly aware of the phenomenal demand of completely new types of products, which has, overnight, created heavy additional demands on our industry. To name only a few—milk bottles, frozen food packaging, and produce packaging were unknown 15 years ago. It is perfectly apparent that new products will constantly appear in this rapidly changing age.

ESSENTIAL PLANNING

Management

It seems to me that, to continue to prosper, there are certain fundamental and basic principles which we must accept. The first of these falls primarily within the responsibility of management. Over the past years, I have had the pleasure of visiting a substantial number of carton manufacturing plants in the United States. I am happy to be able to say that, in most cases, management's attitude in those plants has been progressive and optimistic. In a few, I have heard the argument that the methods which were standard 20 years ago were good enough to turn out cartons, and that all the fuss and bother and the high expenditures on new equipment were ridiculous. This type of management would argue that we should endeavor to maintain a status quo, and to leave well enough alone. I must confess that, in going through such plants, the physical equipment reflected the attitude of management. It would seem to me very surprising if such companies would continue to prosper under present-day conditions, though they may have done extremely well during the sellers' market which existed up to last year.

Management must, in my opinion, spend more time planning for the future. It is essential that a completely open and inquiring mind be maintained on all of the new developments which are now taking place in the industry. I think it is true that we sometimes are a little confused as to whether we could profitably pursue a policy of printing, say, by letterpress, by lithography, by rotogravure, by aniline, or by some other method. Undoubtedly, as in the past, mistakes will be made, but unless the managements of our companies are prepared to move forward in these rapidly changing times, and to spend the money necessary and do the studying required to adapt themselves to new methods and new techniques, then success is doubtful.

It is also management's responsibility to bring continuous pressure to bear on all our suppliers constantly urging them to improve their products. We will need better board, we will need better ink, better machines, better adhesives, and the only way that we are going to get them is to prove their very definite need to the supplier whose time and energy must be devoted to developing them. If we indicate a feeling of self-satisfaction, then we have no reason to complain if our suppliers feel that the product which they have given us in the past is completely satisfactory.

Selling Techniques

Second, it would seem to me a must that our whole conception of selling our customers must change. It seems to me that we are still a little bit bewildered with the rapid change which has taken place, after 12 years in a sellers' market. We have forgotten many of the techniques necessary to sell our product. Unfortunately, we, in Canada, have a type of competitor which I am sure doesn't exist in the United States, who feels that the best way to get the business, when times are a little tough, is to cut a price. This has, of course, been a chronic problem in our industry. A more stupid and more useless practice would be hard to imagine. Obviously, the only possible result is continuously lower prices until someone attains the ultimate in diminishing returns and goes "bust." I will admit that creative and imaginative selling is sometimes slower in getting results, but unless we can maintain sales departments who have active imaginations and a continuing, day-to-day desire to do a better job in merchandising our customers' products, then our degree of success will be, at the most, mediocre. I think it likely that it will be a long time before we see another sellers' market in our industry and, unless we have forceful selling, we are in for trouble.

Human Relations

Third, I think it is extremely important that we give more and more thought to the efficient use of our most valuable asset. Too many of us are prone to think of a company as consisting of a certain amount of working capital which conducts its affairs in a building equipped with a certain number of machines. Basically, a company consists of individuals and, unless we are prepared to recognize the fact that we can produce more and better work by treating our employees as human beings and providing the best in wages, working conditions, and morale, then we have not planned as intelligently as we might. The recognition of the craftsmanship required to perform many of the operations in our plants is something to which we have paid little attention in the past. The men and women who work with us to produce our companies' products are entitled to and need that recognition.

INTEGRATION VS. INDEPENDENT OPERATION

Finally, I would like to make one comment, as a foreigner in your country. From time to time, in conversation with independent carton manufacturers, I have heard the comment that it is becoming increasingly difficult for a nonintegrated company in the industry to compete with larger integrated units. There seems to be a feeling of helplessness. I appreciate the fact that I may be treading on some toes but, speaking as a representative of a nonintegrated business, I cannot help but feel that such an attitude is pessimistic to the extreme, and that it represents very poor reasoning. It is perfectly obvious that there are certain types of volume business which rightly and properly should be produced by an integrated operation. Obviously, the company who can produce profitably at the lowest cost is the logical source for such business. It is true that in your tremendous market there are a large number of accounts of this type, but it is equally true that the great majority of customers requiring cartons from the industry buy them in moderate quantities. In the field of short runs and medium-sized runs, it would seem to me that the nonintegrated manufacturer is in his rightful field and can compete more successfully than his integrated competitor. The ability to buy board tonnage when wanted, and to turn it off when not wanted, is a very substantial advantage in this type of work. Usually, the flexibility of equipment and techniques favor the independent converter. It is my very firm conviction that there is plenty of room for both kinds of companies, and that the future is equally bright, provided we are prepared to work for it.

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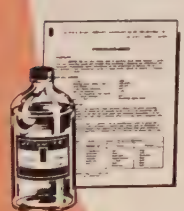

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CONCLUSION

Our past has proved that the folding carton can do a better job than other types of packaging when full consideration is given to its ability to protect and to provide a good merchandising unit. At the same time, it provides very substantial savings in initial cost and in use in the customer's plant. To me, after many years, the folding carton industry is still a fascinating business. I must confess that I still get a thrill when we have been successful, as a company, in producing a package which does an outstanding merchandising job for a customer.

Gentlemen, we are fortunate in being engaged in such an interesting and satisfying type of work. The future of the folding carton industry is assured. There is little to indicate but that the progress made during the past 50 years will continue. Our part in that future is up to us. Let's do the best we can with it!

A group touring the plants on May 22nd, the first day of the Folding Box Forum which was held in Cleveland, Ohio

Cooperative Research for Carton Industry Development

LEWIS K. BURNETT

Our speakers today have reminded us of a number of the problems that we as carton makers and users face.

We hope that through the official and unofficial exchange of ideas that has gone on and probably will go on into the wee hours of tomorrow morning that you will have gained some help in solving some of your problems.

However, I personally hope that we won't stop there. I believe that some of the problems that the carton industry faces are the kind that individuals and individual companies are going to have a very hard time solving alone. I think that cooperative effort is in order if we as an industry are to make the technological progress that we can and should make. Furthermore, I think that we can get some real benefits out of such cooperative effort and that the type of cooperation I have in mind does not interfere in the least with good old American competition.

Each of the carton manufacturers represented here sells in competition with other carton manufacturers and that is as it should be under our free enterprise system. However, as a group we carton manufacturers are also in competition with other forms of packaging and here we have a common interest which calls for cooperative effort to protect and expand the use of cartons. This calls for continual research and development to improve materials, methods, and products.

No single company in the carton industry makes enough of the total tonnage to be able to support this kind of research and development work by itself. However, all of us together can afford to support research of the kind I believe we need and in fact I believe that I should say we cannot afford not to support such a program.

Let me list a few of the outstanding problems which I think could be tackled cooperatively for the good of the carton industry in competition with other forms of packaging.

1. We need a testing method which will numerically evaluate the bending quality of a piece of paperboard. Wouldn't such a method reduce waste and increase efficiency in the carton industry so that we would have lower costs and better satisfied customers?
2. We need an improved method of mechanically cutting uniform female scores. Wouldn't such a technique save many man-hours in the pressroom and insure better and more uniform quality cartons?
3. We need better testing methods for determining whether a carton is going to perform on our customer's filling equipment, in transit and in use by the ultimate consumer.

Lewis K. Burnett, Manager Production Control, Ohio Boxboard Co., Rittman, Ohio.

I believe that these are a few of the basic problems which we as an industry can't afford to allow to go unsolved any longer. Each of you could add to the list and I believe that we as an industry could solve most problems of this kind if we decided we wanted to.

We also have another common interest. Our products are used on filling and sealing machinery which doesn't care whether the John Jones or Henry Brown Carton Co. made them. Because of the very just and desirable demand of our customers for higher speeds and greater production this equipment is getting more and more complicated. We have all had our troubles with filling and sealing machinery that required special carton construction or processing at extra cost which didn't seem necessary when compared to other equipment running at comparable speeds. Obviously the machinery manufacturers cannot make their equipment to meet our individual ideas as to carton manufacturing However, I am sure that they would welcome constructive criticism of the industry. Such cooperative effort would surely result in less headaches for our customers as well as the machinery and carton manufacturers. Therefore, this is an area where I believe we could cooperate effectively.

Let's look at some of the possible ways of going about such cooperative effort. This meeting was jointly sponsored by Folding Box Assn. and TAPPI. The Folding Box Assn. already has a research and technical committee which could be used to head up this type of work. However, they would need real financial and management backing to make appreciable progress.

TAPPI was originally formed for consideration of papermaking and use problems. Within the last ten years its programs have been changed to include board making and board converting problems.

At present TAPPI has no committee working on folding cartons. As chairman of the Converting and Consuming Division of TAPPI I can tell you that there is a place in its committee structure for such a committee. Such a committee could carry on as strong a program as its members wished to sponsor. The Packaging Institute has members from both manufacturers and users of cartons and has already sponsored cooperative effort on use requirements of cartons.

All the technical organizations provide an opportunity to organize for the search and dissemination of knowledge, and to do so in an atmosphere that is generally free from competition.

The Cowles Company

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TEL. AUBURN 3-3214 CAYUGA, NEW YORK

June 23, 1952

AN IMPORTANT MESSAGE
to America's paper-making industry

On June 23, 1952, The Cowles Company, Inc., formally licensed The Black-Clawson Co., Inc., of Hamilton, Ohio, to manufacture and sell three recently-developed Cowles' products -- the "Aquapulper", the "Beatapulper", and the "Classapulper".

These products will be produced and sold by the Shartle Bros. Machine Co., Division of Black-Clawson Co., at Middletown, Ohio. Under our licensing agreement, they will be known as the "Aquapulper", the "Beatapulper", and the "Classapulper". At the same time, The Cowles Company will continue to manufacture and sell the Cowles "Aquapulper", the Cowles "Beatapulper", and the Cowles "Classapulper".

WHAT IT MEANS TO YOU

This licensing agreement will benefit you -- and other members of the paper industry -- in these two ways: First, it will permit speedier delivery than previously was possible of these Cowles-engineered products, since both The Cowles Company and Shartle Bros. plants will manufacture the "Aquapulper", the "Beatapulper", and the "Classapulper". Second, it will enable The Cowles Company to devote more time to the development of new products.

We, at The Cowles Company, feel confident that by licensing The Black-Clawson Co. to produce our products, we can better serve you and America's paper-making industry.

Edwin Cowles
President
THE COWLES COMPANY, INC.
Cayuga, N. Y.

Visitors who inspected several plants during the Folding Carton Forum

First, we have to establish a common language so that we know *what* we are talking about. Second, we must develop techniques for using that language or nomenclature so that we will be able to be highly specific and express ourselves in technical units or figures that will be significant to all concerned. TAPPI, ASTM, and the Packaging Institute all work in this field and are very cooperative, often working on a joint committee basis.

Major efforts to attain research and development objectives are properly planned and financed by the industry itself, represented by such organizations as the Folding Paper Box Assn. On a smaller scale, especially in the development of control methods and apparatus TAPPI and the other professional societies can offer financial aid.

The paper industry established The Institute of Paper Chemistry at Appleton, Wis., partly for the purpose of solving paper industry problems. Most of you are familiar with its success. I believe that the carton industry could arrange to have The Institute of Paper Chemistry or any of a number of other qualified educational institutions carry on research work under the guidance of our own technical committee. Such a plan has proved satisfactory in the case of jute and kraft liner manufacturers.

In a private communication to the writer Westbrook Steele, President of The Institute of Paper Chemistry, and active in the development of The Institute of Textile Technology at Charlottesville, Va., and the Institute of Gas Technology in Chicago, said: "Broadly speaking, it is my firm conviction that segments of an industry which are essentially competitive may jointly and on a cooperative basis effectively pursue research and development collectively. Their problems are common, their needs comparable. Jointly they are planning to invade and insure the retention of markets previously held by other materials or markets which are being looked to as fair game by other media. The agreement as to objectives on the part of these individual segments and the energetic pursuit of these objectives, we believe, will result in a successful program."

Mr. Steele also cited the program of the Structural Clay Products Institute as an example of a recent cooperative development activity undertaken by a segment of an industry.

I know that we here tonight cannot start the kind of program I have proposed. However, I believe that it deserves serious consideration if we are to achieve the kind of technological progress that I believe is necessary to insure sound continual expansion of the carton industry.

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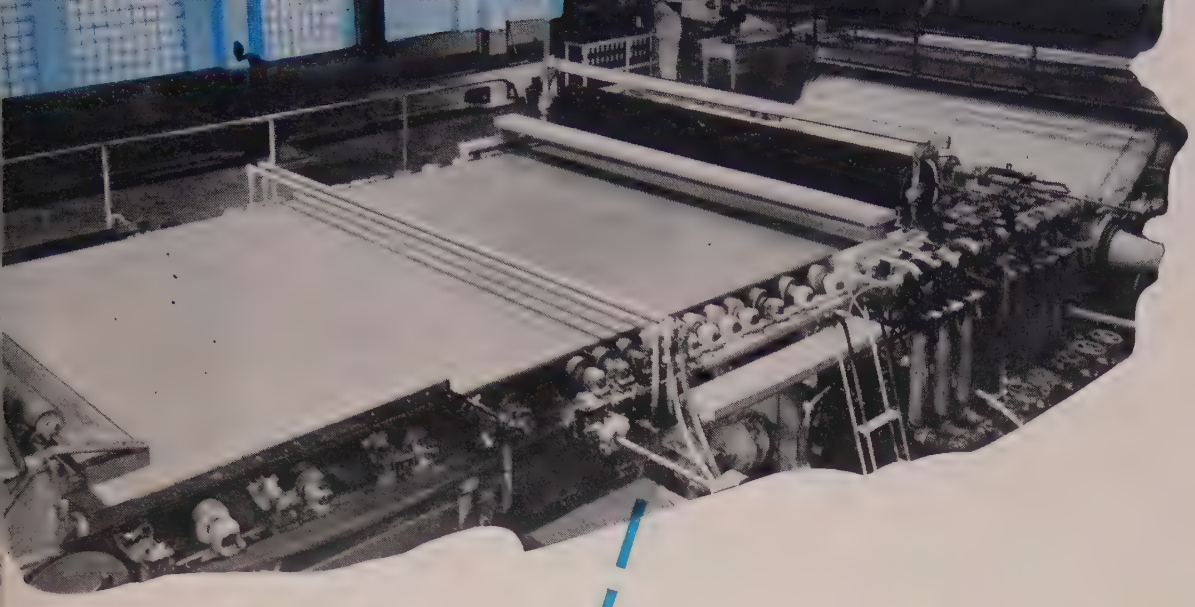

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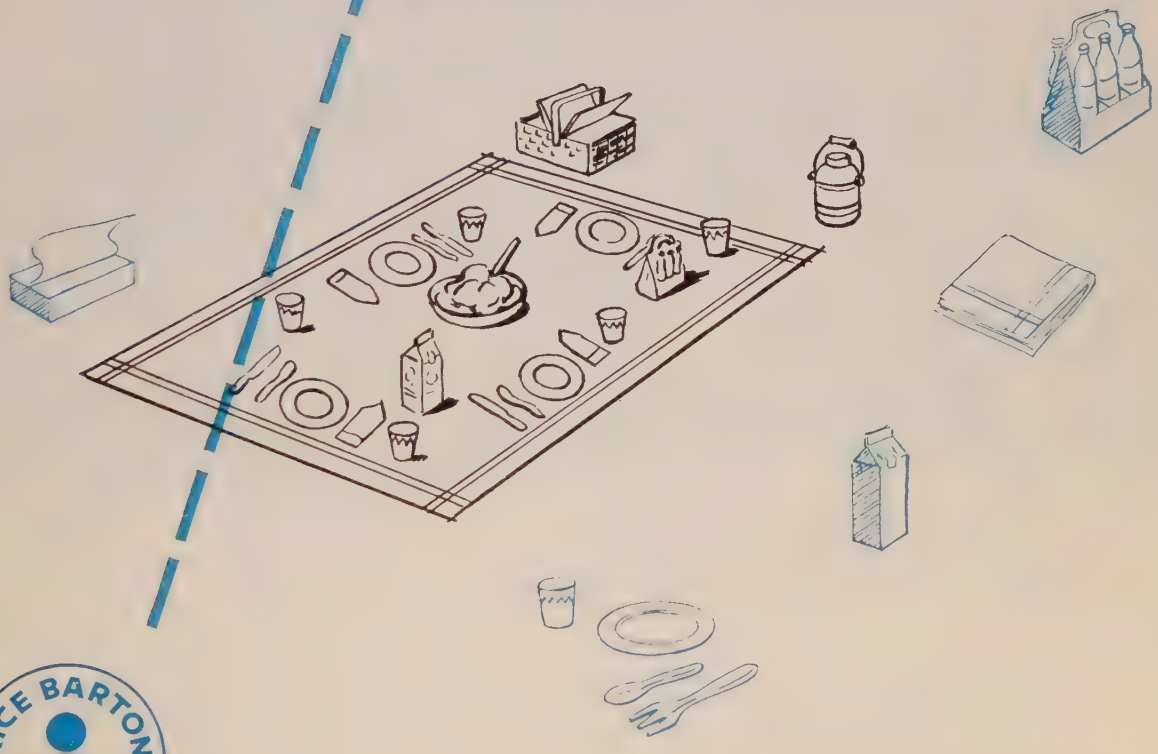

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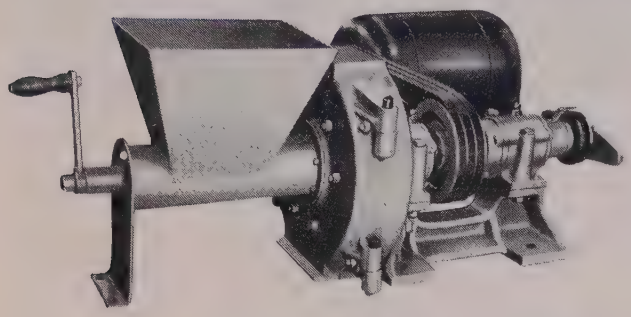

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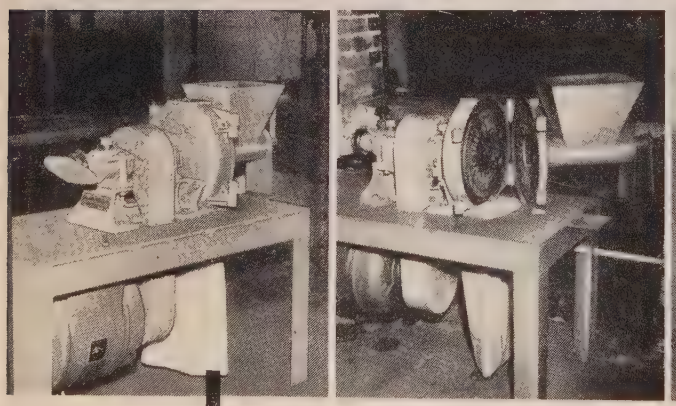

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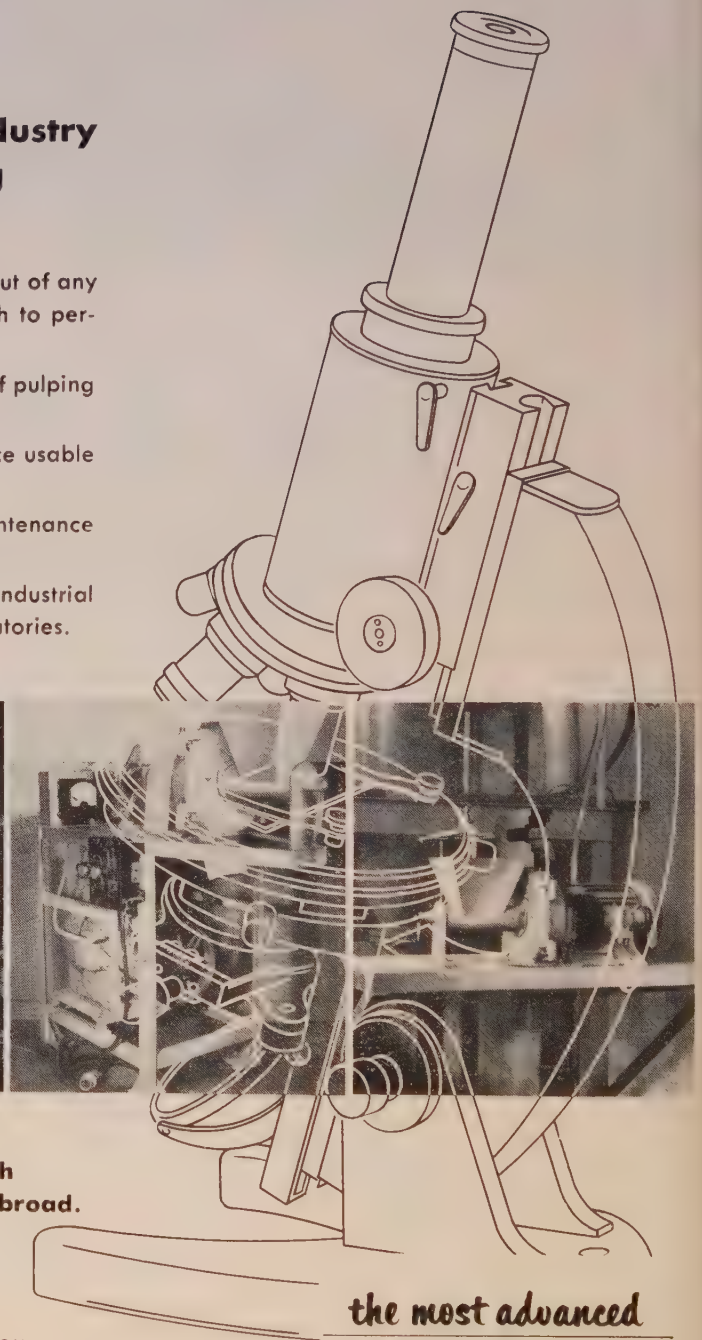

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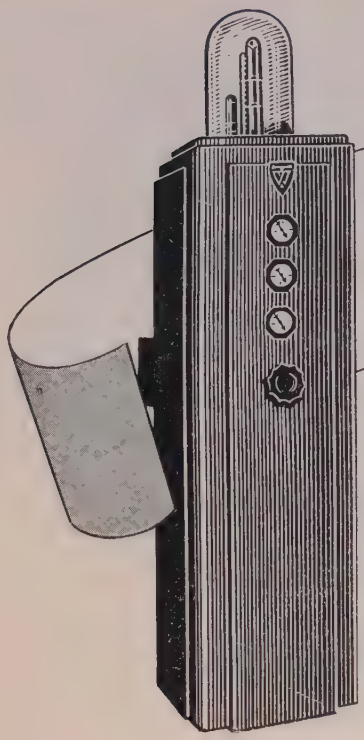

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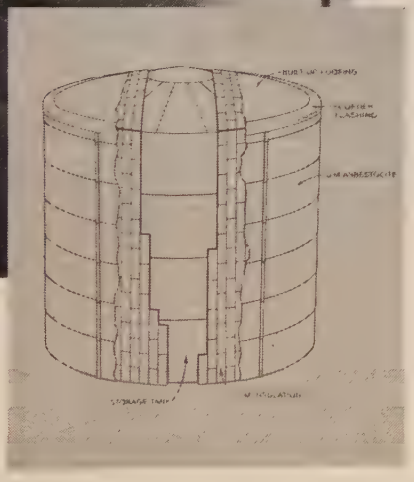

Cutaway drawing shows how Johns-Manville Weather-Protected Insulation is applied to a tank—Standard methods for mechanical securement of the insulation are used. Asbestocite sheets are then applied over the insulation, following a simplified Johns-Manville specification.

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Photographs courtesy of Wool Bureau, Inc.

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Fourdrinier Section Load Requirements

W. MIKELSON

Several modern machines have been studied to determine how power is distributed throughout the fourdrinier elements to provide a basis for the re-evaluation of existing power constants used to calculate and predict power requirements on new machines. A more accurate procedure has been derived.

MANY factors enter into the make-up of load on a fourdrinier section, making this section of a paper machine a difficult one on which to predict power requirements. The primary load is friction between the flat suction boxes and the wire. The secondary load is friction of all remaining sliding and rotating components. Couch roll vacuum adds a little more load.

The ability to calculate these three load components determines to a large extent how well fourdrinier power requirements can be predicted. The Electrical Engineering Committee of the TAPPI Engineering Division in 1949 initiated and sponsored this work to conduct a power study and re-evaluate existing TAPPI practice for calculating fourdrinier power requirements (*1*).

A preliminary analysis was made based on power measurements of four paper machines, and a preliminary report was presented to the Electrical Engineering Committee at the Fifth Engineering Conference of TAPPI held in Cincinnati in October, 1950.

A new formula was established which permits making closer calculation of power requirements than possible with existing TAPPI constants.

Since that time load and vacuum readings have been obtained on seven more machines, bringing the total number of machines studied to eleven. The new data show good agreement with the constants established in the preliminary report. Machine speeds included the range 218 to 1480 f.p.m. Paper weights included the range 30 to 126 lb. per 3000 sq. ft. Paper types included bond newsprint, and kraft. This report combines the preliminary data and the new data. Results are plotted comparing each of the machines studied. Machine and paper data for each machine tested are included.

The detailed procedure and questionnaire used to obtain data and calculate results is included at the end of this report. The procedure for taking data was quite simple. The setup required meters on the couch motor, vacuum gages on each box, and the couch roll, and a surface speed indicator. Prior to a shutdown, a set of readings was taken, shutting off flat boxes one at a time starting at the dry end. Then couch vacuum was removed. These readings have been taken in as little time as 10 min., and do not consume much production time.

W. MIKELSON, Paper & Textile Div., Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

The test data as taken permit division of the fourdrinier load into three parts, each of which may be examined separately. These parts are the flat box load, the couch vacuum load, and the residual load (with stock on but no vacuum either in the flat boxes or couch).

Figure 1 shows how these loads divide percentagewise on each of the machines examined. (Data were taken four times on machine A within a period of one month.) Flat box load is the highest, residual friction next, and finally, couch suction load least. Pertinent data on each of the machines are shown in the table. Flat box load is a function primarily of vacuum in the box. Residual load includes bearing and water friction. Couch roll load, the smallest of the three, often has been assumed to be independent of couch vacuum, but noticeable changes in motor current have been observed as couch vacuum is removed in all tests checked to date. For machine C, mill personnel suspected mechanical contact between the box and the roll, which accounts for the high percentage of total load for this machine.

ANALYSIS OF DATA

Residual friction load, converted to horsepower per 100 f.p.m. per inch width of machine (wire width) analyzed for the machines tested is shown in Fig. 3 (top). Referring back to the operating speed of each machine tested suggests that residual friction may be a function of the square of the speed. Dividing through by operating speed to obtain a new constant for each machine produces the curve plotted at the bottom of Fig. 3. The values plotted on this basis appear to be reasonably close for all machines, and the single value indicated on the graph will be assumed a reasonable average for general use. To prevent this constant from becoming zero at zero speed, a base speed of 100 f.p.m. was assumed and the constant then becomes $0.0025 + 0.000025X$ speed f.p.m. When plotted on a curve of residual power constant versus machine speed the result shows reasonable correlation, Fig. 5.

Couch suction load converted to horsepower per 100 f.p.m. per in. width of wire is shown in Fig. 4. These values seem to fluctuate at random and no correlation appears evident with any other machine data recorded. Even on machine A, where readings were taken on four different days over a period of a month making the same kind of paper, there is no consistent pattern. The suspected rubbing of the box and roll of machine C would explain this high value obtained. In any case, this portion of fourdrinier load is small. The value selected as the average for general use, therefore, as shown on the curve, is above most values plotted, but below the four highest.

Flat box friction was determined last. Header vacuum as ordinarily measured is no indication of flat

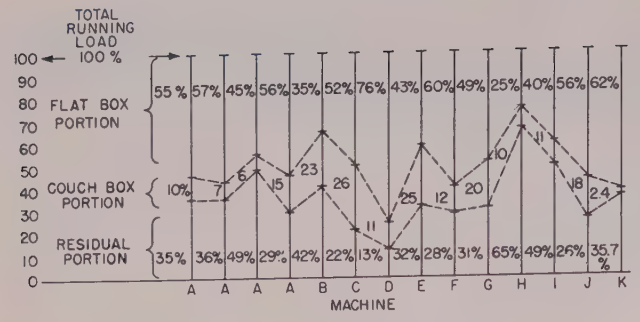

Fig. 1. Fourdrinier load division

box vacuum, as indicated in Fig. 2. It is well known that flat box vacuum is lower. How much lower this can be sometimes comes as a surprise when actually measured by putting vacuum gages on top of the box. For example, the four runs on machine A indicate that the average suction efficiency (average box vacuum per header vacuum), of the five boxes is approximately 15%. Header vacuum actually once was removed completely from all flat boxes and, curiously enough, paper continued to pass through the machine. On machine C, vacuum gages were mounted both on the tender's side and on the back side of the flat box. The first five boxes showed a fairly high vacuum on the back side, but no vacuum on the tender's side. From this it appears that suction efficiency might be expected to vary almost anywhere between 10 and 90% on different machines. It also points up the futility of trying to use header vacuum as an indication of average box vacuum.

In all tests included in this report, an attempt was made to measure vacuum at each box to evaluate the coefficient of friction of each box. Here again another surprising observation was uncovered. It would seem that the coefficient of friction on a wet box would be less than on a dry box because of the effect of water lubrication. Actually it was higher on the wet boxes for two of the machines tested, approximately equal for all boxes on the third machine, and lower on the wet boxes for machine D. Indications leave some doubt as to the effect of water lubrication on flat boxes and it may be assumed for the purpose of this report that the friction of all boxes is of the same order of magnitude.

The average coefficient of friction based on removal of all flat box vacuum is shown for four machines in Fig. 6 which shows the effect of wire age. Figure 7 shows the maximum measured coefficient for all ma-

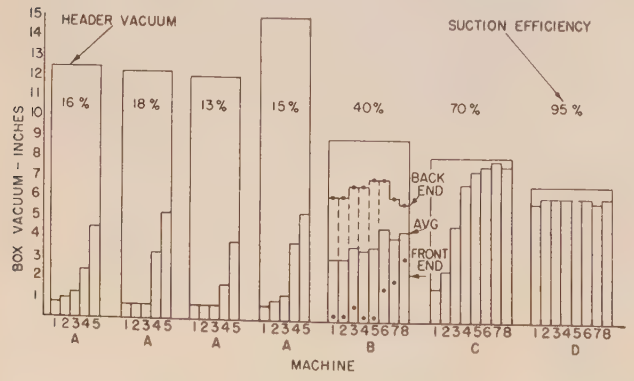

Fig. 2. Flat box vacuum

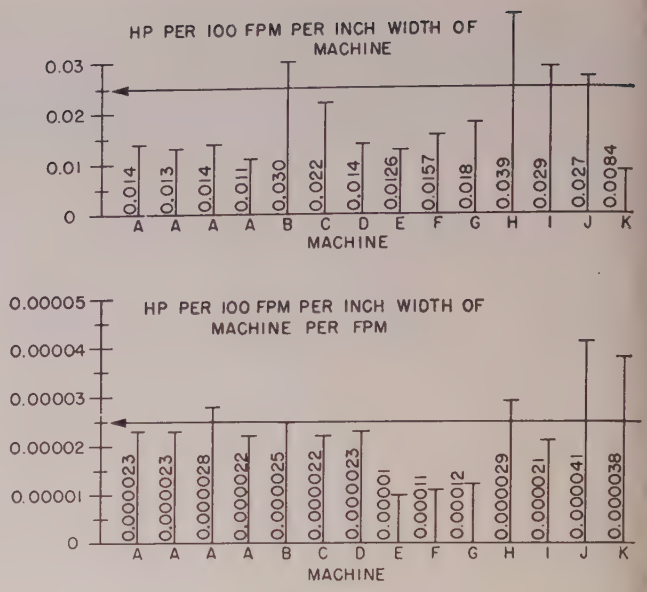

Fig. 3. Residual power constant

chines tested. The values for all except machine A show variation of friction during the life of any one wire plotted on a minimum to maximum range basis. In most cases, coefficient of friction increased with age. Variations as much as two to one are shown for some wires. The values for machine A were spot readings taken on three different wires. Most of the values are well below 0.4 except during the last few days of wire life, and in one case on machine C, when the box covers were dressed, the friction increased to an abnormal value until the wire had worn the surfaces smooth again. Since this is the major part of the load, however, and if 100% operation of the machine is expected, regardless of abnormal conditions or wire age, a value of 0.4 is reasonable for use in general calculations of horsepower requirements.

The general formula based on the preceding analysis of the three contributing fourdrinier loads can be written as follows:

Over-all fourdrinier power constant—hp. per 100 f.p.m. per in width of wire equals:
0.0025 + 0.000025 × wire speed in f.p.m., plus 0.0006 × couch box vacuum in in. + 0.0000059 × average vacuum at boxes, in. Hg × per cent hole area in cover × width of cover × number of boxes

These four terms when added together give the over-

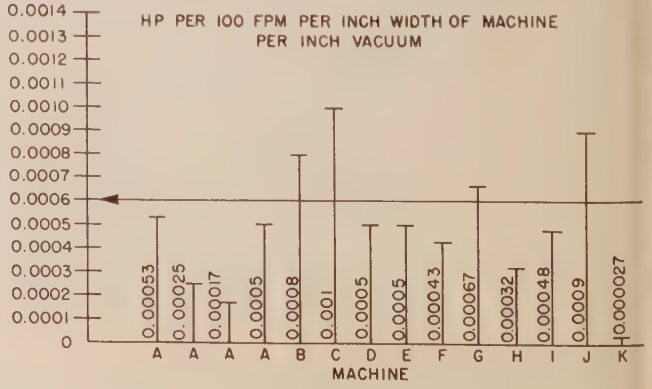

Fig. 4. Couch suction power constant

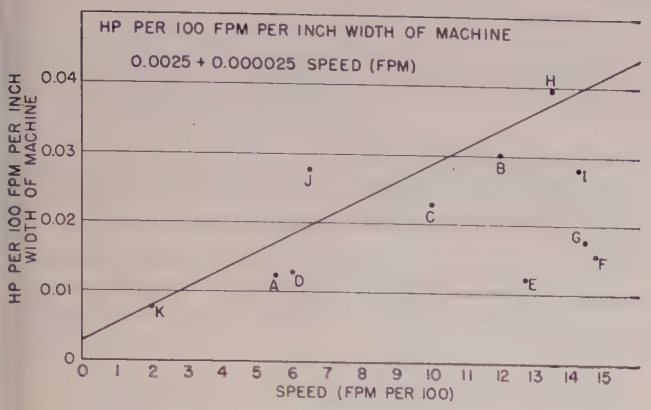

Fig. 5. Residual power constant

all fourdrinier power constant—hp. per 100 f.p.m. per in. width of machine—from which the horsepower of the motor can be calculated.

The table below shows for each machine on which flat box vacuum was measured, a comparison of (a) measured over-all constant—hp./100 f.p.m./in. width, (b) calculated over-all constant—based on new formula, and (c) TAPPI constant.

	(a)	(b)	(c)
Machine A	0.035	0.040	0.075
A	0.032	0.041	0.075
A	0.026	0.035	0.075
A	0.036	0.042	0.075
B	0.080	0.085	0.075
C	0.110	0.108	0.075
D	0.139	0.145	0.075
E	0.039	0.063	0.100

The measured over-all constants vary 4 to 1. The new calculated constants follow the measured values closely. The TAPPI constants vary from twice too much for machine A to only half enough to handle the load for machine D deviating considerably from actual requirements.

By making assumptions for the general case that: (1) couch box vacuum is 24 in. and (2) per cent hole area is 33%, both of which are conservative based on the tabulated data.

The fourdriner power constant—hp. per 100 f.p.m. per in. width of wire:

$$= 0.017 + 0.000025 \times \text{wire speed, f.p.m.} + 0.00019 \times \text{average vacuum at boxes, in. Hg} \times \text{number of flat boxes} \times \text{average width of box, in.}$$

Figure 8 shows horsepower per inch width of machine for a machine rated at 1000 f.p.m. maximum.

Plotted on the same curve is the horsepower obtained using the present accepted TAPPI constant. This shows a value of 0.75 hp. per in. width of wire for this machine, regardless of average vacuum at the flat boxes, and regardless of number of boxes. It will be noted that the average vacuum allowable at the flat

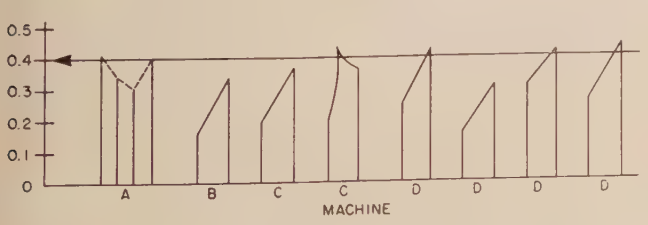

Fig 6. Coefficient of friction-flat box

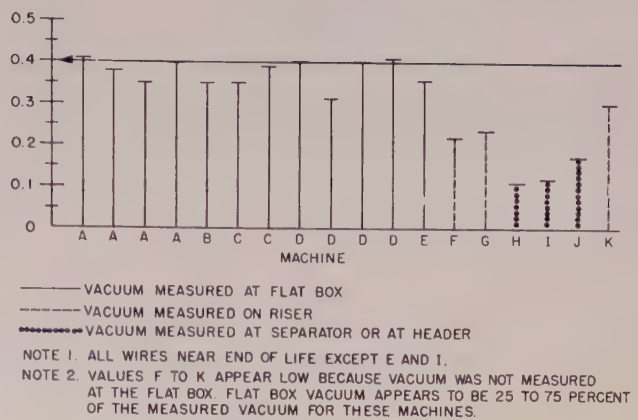
0.5
0.4
0.3
0.2
0.1
0
A A A A B C C D D D D E F G H I J K
MACHINE
VACUUM MEASURED AT FLAT BOX
VACUUM MEASURED ON RISER
VACUUM MEASURED AT SEPARATOR OR AT HEADER
NOTE 1. ALL WIRES NEAR END OF LIFE EXCEPT E AND I.
NOTE 2. VALUES F TO K APPEAR LOW BECAUSE VACUUM WAS NOT MEASURED AT THE FLAT BOX. FLAT BOX VACUUM APPEARS TO BE 25 TO 75 PERCENT OF THE MEASURED VACUUM FOR THESE MACHINES.

Fig. 7 Coefficient of friction-flat box

boxes before this power constant is exceeded is smaller than generally recognized, approximately 3 in.

Vacuum is a fundamental mechanical quantity bearing directly on power requirements. When boxes are added or vacuum *at the flat boxes* is increased, there is always a first-order effect on load. Water removal may or may not be affected appreciably, however, depending on individual circumstances.

It is the responsibility of the ultimate user of the machine to specify the average vacuum expected at the flat box. In the absence of specific vacuum data, it may be helpful to know if the stock is expected to be free or slow. Correlation of the formula above with past experience shows that an average vacuum of 1.5 in. may suffice for a very free stock and 6 in. or more may be required for a very slow stock, with the majority of papers falling into the 2 to 3-in. vacuum class.

The new formula should permit more accurate estimates of fourdrinier power requirements even when operating vacuums are not known or cannot be predicted. The ultimate accuracy of the formula depends on better instrumentation of flat box vacuum by measuring vacuum at the box instead of at the header, particularly on modern high-speed machines operating with a large number of wide flat boxes, and at high values of flat box vacuum. Modern designers of such machines, however, recognize the importance of accurate vacuum instrumentation for papermaking reasons and it is expected most new machines will have facilities for providing this information readily.

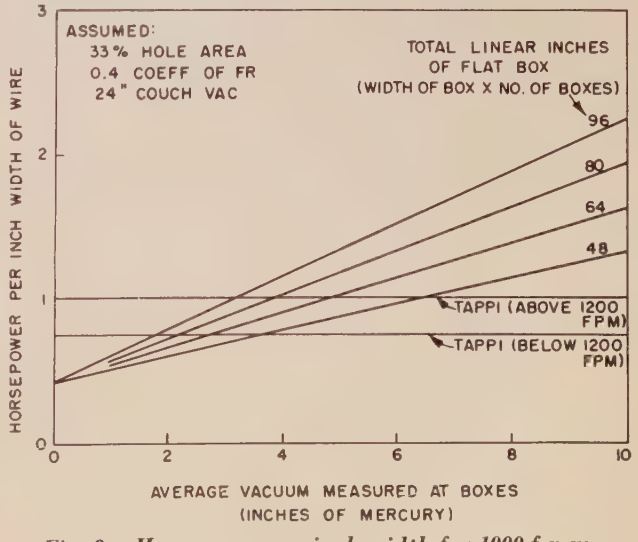

Fig. 8. Horsepower per inch width for 1000 f.p.m. machine

A SUGGESTED PROCEDURE FOR INVESTIGATING COUCH LOAD

The couch load make-up includes primarily friction load of the wire on the flat boxes and secondary friction of other water removal rolls and of bearings.

By removing loads one at a time, noting at the same time the change in motor current, the magnitude of each load can be evaluated.

Step Removal of Couch Loads

In addition to the header vacuum, it is necessary that a separate gage be mounted at each flat box, on the box preferably, or as close to the box as possible. It is desirable if possible also to mount gages on the front end of the box to check pressure drop in the box.

With stock on and couch loaded for normal paper-making read *motor amperes*, and read *all vacuum gages*, including *header* vacuum and *couch roll* vacuum. Leave couch roll vacuum on and remove vacuum on flat box starting at the couch roll end; readjust remaining vacuums to their original value if possible; read motor amperes and all vacuum gages. Remove second flat box vacuum and do the same. Remove each flat box vacuum in turn; proceeding toward the wet end; re-adjust remaining vacuums each time and read amperes and vacuum gages. If auxiliary rolls such as dandy rolls are used remove these in turn along with the flat boxes and read instruments as before.

Note: Where possible measure moisture in the sheet at the couch as each box is removed. Although it has no direct bearing on calculation of power, it is an important factor in fourdrinier operation. Similar measurements in one case showed that one third of the boxes could be removed, load decreased, and wire life increased without affecting water removal.

Next remove vacuum from couch roll and read motor amperes, stock on. Then shut off stock and read amperes.

An old wire requires from 30 to 50% more power than a new wire. For this reason, a separate run is desirable for each condition. If only one run is made, it should be made on an old wire.

During the life of one or more wires while making paper, take current and vacuum readings daily or more often if changes of weight or grade are being made. Record also weight and grade of paper.

Record also the following technical data:

1. Wire speed during test, f.p.m.
2. Sheet width, in., on wire.
3. Number of flat boxes.
4. Width of each flat box cover, in.
5. Area of each box cover, (2) × (4), sq. in.
6. Area of holes in each cover, sq. in. See note below.
7. Per cent hole area to total area, each box, 100 × (6)/(5).
8. Rated hp. of motor.
9. Rated speed of motor, r.p.m.
10. Rated current of motor.
11. Speed of motor during test, r.p.m.
12. Rated voltage of motor.
13. Dimensions and area of one hole in flat box cover.
14. Countersinking detail for flat box holes, approx.
15. Per cent of rated field on motor.
16. Couch gear ratio.
17. Couch roll diameter.

Record also the following general data:

(a) Type of furnish used during test run.
(b) Type of paper.
(c) Thickness, in.
(d) Basis weight per 3000 sq. ft.
(e) Consistency of furnish in headbox.
(f) Freeness of furnish in headbox.

Machine	*A*	*A*	*A*	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
Wire speed, f.p.m.	615	560	500	500	1182	1010	600	1270	1480	1470	1355	1410	653	218
Rated machine speed, f.p.m.	800	800	800	800	1320	..	2000	2000	1650	1650	1600	1600	2000	500
Sheet width on wire, in.	123	123	123	123	232	234	180	211	265	305	220	220	206	112
Age of wire	Old	Old	Old	Old	Old	Old	Old	30%	Old	Old	Old	Med.	Old	..
Number of flat boxes	5	5	5	5	8	8	8	7	7	7	8	8	10	4
Width of boxes, in.	9.5	9.5	9.5	9.5	8	7.9	12	3–11¾, 4–7¾	7	7	12	12	11¼	7
Cover material	Maple	Maple	Maple	Maple	End grain maple	End grain maple	End grain maple	End grain maple	End grain maple	End grain maple	6-Ryertex 2-maple, dry	1-Ryertex, 7-maple	Ryertex	Maple
Hole size, in.	..	..	..	..	⅝ diam.	⅝ diam., C.S. to ¾	7/16 × 11/16 oblong	½ diam.	19/32 diam.	19/32 diam.	9/16 slots, ¾ holes	9/16 slots, ⅜ holes	⅝ diam.	½ slots
Hole area, %	28	28	28	28	31	31.5	34	26	30	30	33	33	1–29, 9–21	29
Riser diameter, in.	3	3	3	3	..	5.5	8	3–10, 4–8	5	5	..	..	..	..
Header diameter, in.	6	6	6	6	..	18	..	10	14	14	16	..	..	..
Average flat box vacuum, in. Hg	2	2.2	1.5	2.3	3.6	5.7	5.9	1.8	..	..	..	..	..	4.5
Average riser vacuum	..	..	..	..	..	..	..	1.8	7.5	6.3	..	..	..	..
Average separator or header vacuum	..	..	..	..	..	..	..	1.8	..	..	2.8	6	9.1	..
Suction efficiency, %	16	18	13	15	40	70	95	100	..	..	..	..	..	..
Couch vacuum, in. Hg	10	12.5	14	14.5	18.5	23.5	24	17	16.5	17	15.1	15	22	20
Type of paper	Mimeo	Bond	Bond	Bond	Newsprint	Newsprint	Kraft	Kraft	Newsprint	Newsprint	Kraft	Kraft	Kraft	Bond
Thickness of paper, in.	0.004	0.005	0.006	0.006	0.0033	..	..	0.0025	0.0031	0.0031	0.0052	0.0052	0.012	0.0055
Weight, lb./3000 sq. ft.	37	46	56	56	32	..	112	30	32	32	50	50	126	64
Consistency in headbox	0.53	0.66	..	..	0.65	0.60	..	0.20	0.58	0.58	0.28	0.29	0.44	..
Freeness in headbox	..	..	..	..	54	38	..	415	50	50	820	820	700	..

(g) Wire mesh.
(h) Wire age, days, and normal wire life.
(i) Material used for box covers.
(j) Top speed of machine, f.p.m.
(k) Speed range of machine.
(l) Types of paper made on machine.
(m) List papers in order of couch load required.
(n) For each paper list normal motor current and vacuum.
(o) For each paper list motor current with all vacuum off, stock on.
(p) Make one line loop diagram showing configuration of couch wire, all boxes, breast roll, couch roll, scrapers, table rolls, return rolls, work rolls, forming board, showers, etc. Note type bearings used.
(q) Make one line diagram showing vacuum lines, boxes, separators, water legs, header, valves, vents to atmosphere, vacuum gage locations, diameter, and length of lines to flat boxes, etc.
(r) White water flow. U. S., g.p.m.
(s) Moisture content of sheet leaving fourdrinier.

Note: If hole is countersunk, use average diameter of countersink to calculate hole area. For example, if hole diameter is $^5/_8$ in. and is countersunk to $^3/_4$ in., use a diameter of $^{11}/_{16}$ in. to calculate hole area.

Calculations

A. *Calculate horsepower per ampere of couch motor.* Refer to numeral list of technical items in this report.

$$\frac{\text{hp.}}{A} = \frac{(8) \times (11)}{(10) \times (9)}$$

If test runs are made at several speeds calculate hp./A for each speed.

The above formula is correct for rated field current on the motor field. If the motor current is a few per cent high or low correct the hp./A figure by one half the percentage.

For example, if field current is 5% high increase hp./A by $2^1/_2$% the effect of field saturation.

B. *Calculate horsepower of residual friction load.* Residual friction load is the load with all vacuum shut off, stock on.

$$\text{Hp.}_{\text{res.}} = \frac{\text{hp.}}{A} \times \text{motor current (no vacuum)}$$

The term "motor current (no vacuum)" means all current except vacuum load. It includes any non-vacuum loads removed during test such as dandy roll, etc.

C. *Calculate horsepower of vacuum load on couch suction box.*

$$\text{hp.}_{\text{csb}} = \frac{\text{hp.}}{A} \times \text{current change when couch vacuum was removed} \times \text{ratio of initial couch vacuum over final couch vacuum}$$

D. *Calculate horsepower of vacuum load on all flat boxes.*

$$\text{hp.}_{\text{afb}} = \frac{\text{hp.}}{A} \times \text{current change due to vacuum removed from all flat boxes}$$

This current change means first of all the difference between total operating current and current reading with all flat boxes off. Then it should be corrected for couch vacuum change, if any, during test. Also subtract any nonvacuum loads removed during test such as dandy roll, etc.

E. *Calculate total horsepower.*

$$\text{hp.}_{\text{total}} = \text{hp.}_{\text{res}} + \text{hp.}_{\text{csb}} + \text{hp.}_{\text{afb}}$$

Check this total with result obtained from formula. $\text{hp.}_{\text{total}} = \text{hp.}/A \times$ total operating current.

F. *Calculate horsepower removed at each flat box.*

$$\text{hp.}_{\text{box}} = \frac{\text{hp.}}{A} \times \text{current change when vacuum on flat box removed}$$

G. *Calculate coefficient of friction for each flat box.*

$$F_{\text{box}} = \frac{6{,}700{,}000 \times \text{hp.}_{\text{box}}}{(1) \times (2) \times (4) \times (7) \times (\text{vacuum, in.})}$$

For identification of numerical items in formula above refer to tabulated list of technical items listed in this report.

If when the vacuum on this flat box was removed, the other flat box vacuums were not held constant, the "vacuum" in the formula above should be the net change in vacuum of all the boxes.

H. *Calculate average coefficient of friction of all flat boxes.*

$$F_{\text{av.}} = \frac{6{,}700{,}000 \times \text{hp.}_{\text{afb}}}{(1) \times (2) \times \Sigma(4) \times (7) \times (\text{vacuum, in.})}$$

The expression "$\Sigma(4) \times (7) \times$ (vacuum, in.)" means calculate (4) $\times$ (7) $\times$ (vacuum, in.) for each box and add them together.

Sample Calculations

The following test made on a paper machine illustrates the method of calculating the results. The paper being made was kraft board, 112 lb. per 3000 sq. ft. current and vacuum data are given in Table I. Other data are listed in the tabulation which follows. These tests were made on a new wire.

Table I

Motor current	Couch vacuum, in.	Flat box vacuums, in. Dry 1	2	3	4	5	6	7	Wet 8	Current change	Net vacuum change
1250	24	6	5.6	6	6	6	6	6	5.5	..	..
1050	24	..	5.6	6	6	6	6	6	5.5	200	6
1000	24	..	..	8	7.6	6	7	7	7	50	[a]
950	24	..	..	..	9	9	9	9	8.5	50	[a]
900	24	..	..	..	..	11	11	11	10	50	[a]
800	24	..	..	..	..	..	13	12	12	100	6
550	24	..	..	..	..	..	..	14	12	250	11
400	24	..	..	..	..	..	..	..	12	150	14
300	24	..	..	..	..	..	..	..	..	100	12
160	..	..	..	..	..	..	..	..	..	140	..

[a] The net vacuum change was so small that calculations for these specific boxes were omitted due to questionable accuracy. In this test, box vacuums were not held at their original value as dry boxes were removed. More accurate results will be obtained if this is done.

Technical Data:

1. Effective machine speed = 600 − 25 = 575 f.p.m.
2. Sheet width = 180 in.
3. Number of boxes = 8.
4. Width of each flat box = 12 in.
5. Area of each box cover = 12 × 180 = 216 sq. in.
6. Area of holes in each cover = 735 sq. in.
7. Per cent hole area to total area = $\frac{735}{216} \times 100 = 34\%$.
8. Rated horsepower of motor = 400.
9. Rated speed of motor = 1150 r.p.m.
10. Rated current of motor = 1400 amp.
11. Speed of motor during test = 362 r.p.m.
12. Rated voltage of motor = 230 volts.
13. Dimensions of one hole in flat box = $^7/_{16}$ by $^{11}/_{16}$ in., over-all with semicircular ends.

Calculations

A. Horsepower per ampere of couch motor at 362 r.p.m.:

$$\frac{\text{Hp.}}{A} = \frac{400 \times 362}{1400 \times 1150 = 0.09}$$

Motor field was supplied with rated current so no correction need be made.

B. Horsepower of residual friction load:

$$\text{hp.}_{\text{res.}} = 0.09 \times 160 = 14.4 \text{ hp.}$$

C. Horsepower of vacuum load on couch suction box:

$$\text{hp.}_{\text{csb}} = 0.09 \times 140 = 12.6 \text{ hp.}$$

D. Horsepower of vacuum load on all flat boxes:

$$hp._{afb} = 0.09 \times 950 = 85.5 \text{ hp.}$$

E. Total horsepower:

$$hp._{total} = 14.4 + 12.6 + 85.5 = 112.5 \text{ hp.}$$

F. Horsepower removed at each flat box:
Box No. 1:

$$hp._{box} = 0.09 \times 200 = 18 \text{ hp.}$$

The calculations for the remaining flat boxes are tabulated in Table II.

G. Coefficient of friction for each flat box:
Box No. 1:

$$F_{box} = \frac{6{,}700{,}000 \times 18}{575 \times 180 \times 12 \times 34 \times 6} = 0.48$$

The calculations for the remaining flat boxes are tabulated in Table II.

H. Average coefficient of friction of all flat boxes:

$$F_{av.} = \frac{6{,}700{,}000 \times 85.5}{575 \times 180 \times 12 \times 34 \times 47.1} = 0.29$$

Sum of all flat box vacuums.

Table II. Horsepower and Friction Values for Each Flat Box. Refer to Items F and G for Sample Calculations

Box No.[a]	1	2	3	4	5	6	7	8
Horsepower per flat box	18.0	4.5	4.5	4.5	9.0	22.5	13.5	9.0
Coefficient of friction, each flat box	0.48	–	–	–	0.24	0.33	0.15	0.12

[a] See Table I footnote.

LITERATURE CITED

1. Goodrich, A. S., *Tappi* 33, No. 3: 113–117 (March, 1950).

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Dyeing Paper White

M. C. HUTCHINS, E. I. STEARNS, and F. O. SUNDSTROM

The first part of this paper discusses the methods by which the whiteness of paper can be improved, including the chemical bleaching of the pulp, the addition of a white pigment, the addition of a blue dye, and the addition of a fluorescent dye. A comparison of the different methods and the theoretical evaluation of whiteness are considered. The second part is concerned with the various methods for the addition of fluorescent dyes. The various effects were studied and recommendations are given for most effective usage.

The whiteness of paper has been the subject of extensive research by various investigations in the pulp and paper industry (*2, 3, 12*). This previous work, however, was limited to evaluation of whiteness and did not discuss the many important color problems connected with the manufacture of white paper. The purpose of this article is to discuss the attainment of whiteness of beater-dyed paper in general and, in particular, to give data relating to the application of the new whitening agents by beater dyeing and other methods of coloring.

PART I—GENERAL PRINCIPLES

There are two points established by previous research (*2, 3*) which should be kept in mind: first, perhaps there never will be a universally accepted standard of whiteness for the following reason. Some observers favor a white which tends toward the theoretical ideal of a perfectly reflecting, perfectly diffusing surface which is closely approached by freshly prepared magnesium oxide standard. Other observers favor a white which might be called a "natural paper white," that is, a color of paper made from a good grade of well-bleached pulp to which no dye has been added. The "natural paper white" is slightly brownish compared to the "magnesium oxide white." Still other observers appear to be somewhat inconsistent in their preferences. Thus, when dealing with large differences in whiteness, everyone will agree on which is the whiter of two samples but when dealing with small improvements, individual preferences enter and all one can say is that the customer is right; his choice is the best white.

The second important point proved by the previous studies is that improvement in whiteness can result by either of two mechanisms. If the paper is made to reflect more light, it appears whiter, or, if the reflected light is made more neutral* in color, the paper appears whiter. The addition of a substance to the pulp will have a whitening action if it can bring about either of these two effects.

In general, there are four ways that the whiteness of paper can be improved in its manufacture. These are: (1) chemical bleaching of the pulp, (2) addition of a white pigment, (3) addition of a blue dye, and (4) addition of a fluoroscent whitening agent.

Chemical Bleaching

The chemical bleaching of the pulp, although the most important method of improving whiteness, will not be discussed here except to describe its optical effect. Unbleached pulp in general is colored as though a natural brown dye was present. Chemical bleaching destroys this natural dye. The destruction of this brown color results in both an increase of reflectance and an increase in neutrality of reflected light as shown in Fig. 1 by spectrophotometric curves. Thus, whiteness is introduced by both of the established mechanisms. The first small quantity of bleach which acts on naturally colored pulp has a noticeable effect. As more and more bleach is added, the pulp is less and less affected until finally an ultimate color is reached which will not change with further bleaching. This is the "natural paper white" and is somewhat less reflecting and somewhat browner than "magnesium oxide white." The effect of bleaching is shown schematically in Fig. 2.

Pulp of any degree of chemical bleaching can be subjected to other treatment in an effort to bring about

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* Neutral may be defined as gray; achromatic; possessing no hue. A paper which is perfectly neutral in color has equal reflectance at all wavelengths in the visual range.

further whitening. There is no way to accommodate individual preferences of shade in the process of chemical bleaching. Additional bleaching merely removes more of the brown color. In practice, after the desired amount of bleaching has occurred, individual preferences are accommodated by the addition of small amounts of red, blue, or green dye.

Addition of White Pigments

A second way to improve whiteness is to add a pigment that is whiter than the pulp. A typical pigment of this type is titanium dioxide. (Unitane 0-110®). Considering only its whitening effect, the addition of titanium dioxide raises the whiteness of the paper from its original value toward the whiteness of the pigment itself. This is illustrated in Fig. 3 by spectrophotometric curves. The titanium pigment has its maximum effect when added to stock of low brightness. Thus, in Fig. 4, curve A indicates schematically how a stock of low brightness is improved by increasing amounts of titanium. This curve is extended far beyond the practical limits of pigment concentration to indicate that a constant ultimate value would be reached which is the whiteness of the titanium dioxide itself.

If the stock is partially bleached and a white pigment is added, the effect will again be to approach ultimately the whiteness of the pigment, but since the starting stock is closer to this ultimate white, there is less over-all improvement. This is indicated by curve B of Fig. 4. This curve starts higher on the whiteness scale because the starting stock is brighter but ends up far beyond practical concentrations on the same whiteness value as curve A.

If the stock is well bleached, the whitening action is suggested by curve C of Fig. 4. This curve starts very high on the whiteness scale and is nearly flat. The color of the starting pulp is so close to that of the pigment that relatively there is little room for improvement by changing to the whiteness of the pigment.

It is not meant to imply that the same whiteness can be attained with stock of any degree of brightness just by adding titanium dioxide. All stocks are improved in whiteness by the addition of titanium dioxide

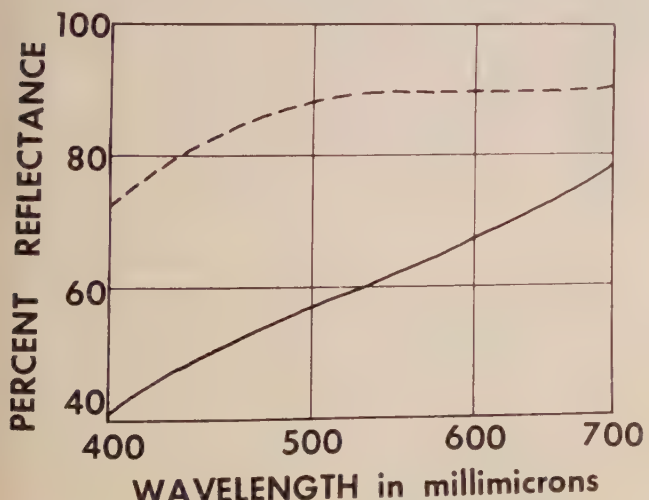

Fig. 1. Improvement of brightness by bleaching

The solid curve shows the reflectance of a sheet of unbleached sulphite paper. The dotted curve shows the reflectance curve of bleached sulphite paper.

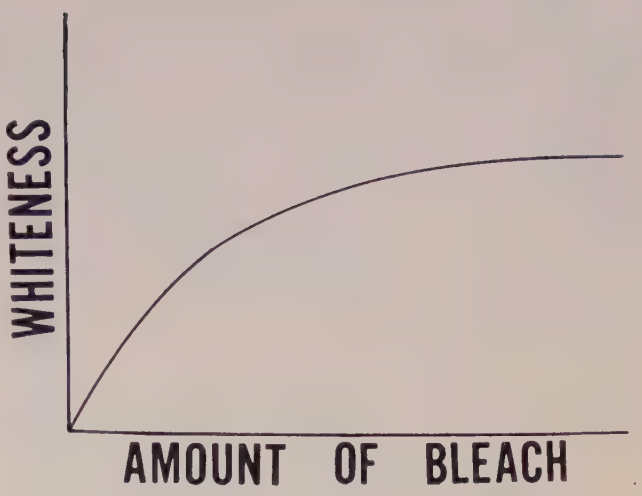

Fig. 2. Improvement of whiteness by bleaching

This curve shows schematically how the first quantities of bleach added are able to improve the whiteness of a sheet of paper but that after a large amount of bleach has been added, and there is no longer any natural brown color matter remaining to be destroyed, no further improvement in whiteness can result.

but this improvement is only a first step toward the theoretical, ultimate color, the color of the pigment itself. It is this first step which is greater for stocks of low brightness. Because of practical limitations in amounts that can be added, the theoretical ultimate can never be reached in beater dyeing. For paper made by a combination of chemical bleaching and a practical limiting concentration of the titanium pigment the whiteness will be greater for the paper made from the stock of greater brightness.

Since the color of a suitable white pigment is generally more neutral than the stock, and since the white pigment generally reflects more light than the stock, the change toward the whiteness of the pigment is an improvement by both of the established mechanisms.

This same principle applies to all white pigments. Of course, if a dark clay is the pigment in question it would whiten only stocks of very low brightness. Its effect on stock of high brightness might be to lessen the whiteness. The addition of increasing quantities of clay would alter the color of the paper made from the well-bleached stock toward the color of the clay itself and this might well be less white than the unpigmented stock.

It is fully realized that the purpose of adding a pigment is usually to impart other characteristics than whiteness. For example, two important properties affected by pigmentation are printability and opacity. Nevertheless there is occasionally some permissible alteration in the formula, for instance, the substitution of titanium dioxide for clay specifically to achieve improved whiteness.

Addition of Blue Dye

A third way to improve whiteness is to add a dye, usually but not always a blue dye. As more and more of a typical blue dye, such as Helmerco® Blue MGW Conc., is added, the paper eventually becomes blue. Between the conditions of no dye, which is the slightly

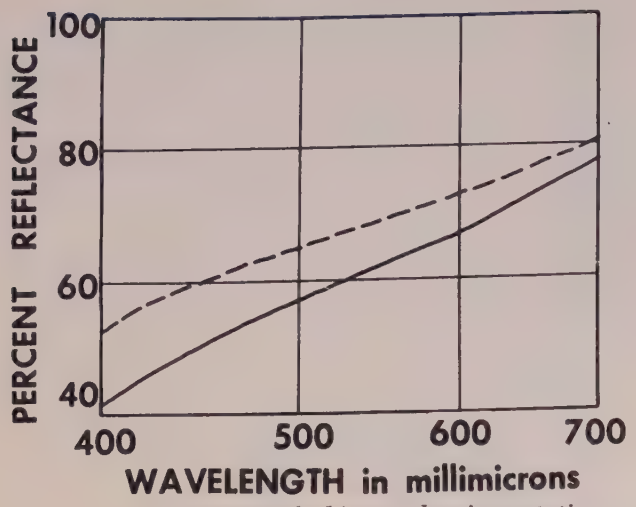

Fig. 3. Improvement of whiteness by pigmentation

The solid curve shows the reflectance curve of an unpigmented sheet. The dotted curve shows the reflectance of the sheet containing 30 lb. of titanium dioxide per 1000 lb. of pulp.

brown paper, and much dye, which gives a blue paper, is a certain concentration of dye which gives a neutral color.

The addition of blue dye invariably results in a decrease of over-all light reflectance. This effect is illustrated in Fig. 5 by spectrophotometric curves. However, the beneficial effect of increased neutrality imparted by the blue dye is more important than the detrimental effect of reduced light reflectance and the combined result is improved whiteness over a limited range of dye concentration. Since at high dye concentrations the effect of additional dye is to decrease the neutrality toward the blue and also lower the light reflectance, the net effect is to decrease the whiteness very rapidly in this concentration range.

The typical effect of increasing concentrations of blue dye is shown schematically in Fig. 6, curve B. A medium bleached stock is improved in whiteness and then degraded with increased concentration of blue dye.

A stock of low brightness is very difficult to improve with a blue dye. In order to add enough dye to neutralize the intense brown color, so much need be added that the light reflectance is decreased considerably. This decreased reflectance is nearly as detrimental as the neutrality is beneficial and the net result, as suggested by curve A of Fig. 6, is that only a small amount of improvement in whiteness can result from adding blue dye to a stock of low brightness.

A stock of high brightness has so little natural brown color in it that a very little blue dye will effect complete neutrality. Thus the point of maximum whiteness is reached with a very small concentration of blue dye. Further, since the stock is so slightly off neutral color to begin with, only a slight improvement in whiteness can result from the blue dye. This is shown schematically by curve C of Fig. 6.

An important characteristic of the effect of addition of blue dye to stock to improve whiteness is that it is most efficient on stocks of medium brightness.

Some of the light-fast dyes that are generally used, arranged in order of shade from a red shade to a green shade, follow:

Table I. Fast-to-Light Dyes Commonly Used to Improve Whiteness[a]

1.	Calcoloid Pink FFD Double Powder
2.	Helmerco Red 6GC
3.	Helmerco Blue M4R Conc.
4.	Helmerco Blue M2RW Conc.
5.	Ultramarine Blue[b]
6.	Helmerco Blue MGW Conc.
7.	Calcoloid Blue BLD Double Powder
8.	Helmerco Blue MG Conc.
9.	Helmerco Blue M2G Conc.
10.	Helmerco Blue M5G
11.	Calcotone ® Blue G Paste
12.	Helmerco Green BGC

[a] In general, these dyes have been considered in the above discussion as if they were all blue dyes. Actually it is occasionally desirable to use a red or a green dye.
[b] There are a number of shades of Ultramarine Blue.

This is illustrated on the color map† of Fig. 7. In this figure, the point numbered 0 corresponds to the color of the undyed stock and the points labeled 1 to 12 correspond to the dyes so numbered in Table I. The addition of Helmerco Blue M4R Conc. to the paper stock will produce a color change along the line from point 0 to point 3. This line falls on the pink side of neutral. The line from point 0 to point 11 suggests that the addition of Helmerco Blue M5G will produce a neutral white with a green tint. The line from point 0 to point 7 or 8 falls very close to exact neutral. However, there is no universally accepted standard of whiteness, and therefore, the usual procedure is to match the submitted white of the customer, or if he has no standard, to offer him several whites from which he may choose one. These whites are made to differ in shade from pinkish to greenish by varying the dye added and to differ in shade from yellow to blue by varying the quantities of blue added.

One reason for having so many different shades of dye is that people have different ideas about what comprises good white. Another reason is that slightly

† The points on the color map are not fixed exactly by precise measurements. The color map is a schematic representation which is often found useful in understanding color relationships (*11*).

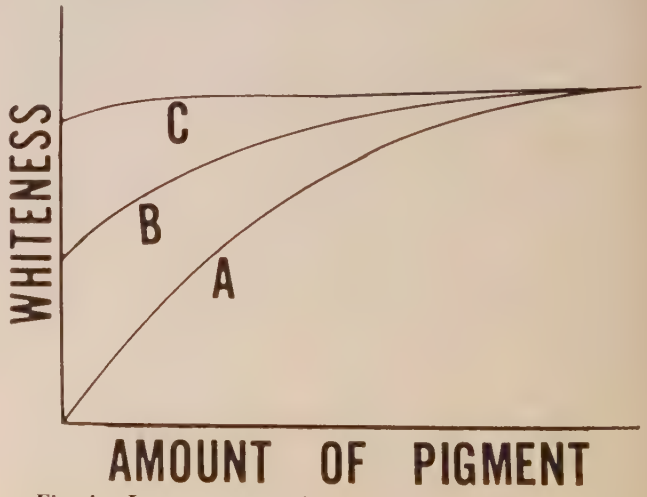

Fig. 4. Improvement of whiteness by pigmentation

These curves show the effect of increasing concentrations of titanium dioxide on stock of various degrees of brightness. Curve A shows the large increase in whiteness which can be imparted to a stock of low brightness. The whiteness of the pigment itself is the theoretical ultimate. Curve B shows how a stock of medium brightness can be improved. Curve C shows that very little additional whiteness can be imparted to a sheet which is very white to begin with by pigmentation because the whiteness of the unpigmented sheet is almost as great as the whiteness of the pigment.

bleached stock of medium brightness will generally be better whitened by red shade blue dyes while well-bleached stocks are generally better whitened by green shade blue dyes.

The dyes listed above have good light fastness and are used on all grades of white. For those stocks, which of their own accord tend to discolor under the action of light, and on which light fastness is not important, a cheaper line of dyes may be used. Some dyes generally used for this purpose are the basic dyes listed below in order of redness to greenness, the reddest ones being listed first:

Table II. Basic Dyes Generally Used to Improve Whiteness

1.	Rhodamine 6GX
2.	Rhodamine BXP Conc.
3.	Methyl Violet 4BPX Conc. Dustless
4.	Brilliant Blue 2R Concn.
5.	Violet 6BN Powder
6.	Ethyl Violet
7.	Basic Blue FN Ex. Conc. Dustless
8.	Victoria Pure Blue BO
9.	Victoria Blue B Extra Conc.
10.	Methylene Blue 2B Conc. Dustless

These basic dyes are plotted on a color map in Fig. 8. Except for the lesser cost and lesser light fastness, the same considerations apply to these dyes previously discussed. The important points are: (1) they induce whiteness by neutrality only, (2) a variety of shades of white can be produced, and (3) these dyes are most efficient on stock of medium brightness.

Blue dyes are commonly added to formulas already containing white pigments for producing desired shades of white and to introduce additional whitening. For groundwood papers loaded with clay, the basic dyes are frequently used while for the more permanent papers containing titanium dioxide the dyes of Table I are more generally used.

In addition the two groups of dyes listed in Tables I and II, many of the acid and direct blues and violets are utilized for the production of whites in many grades of paper and board.

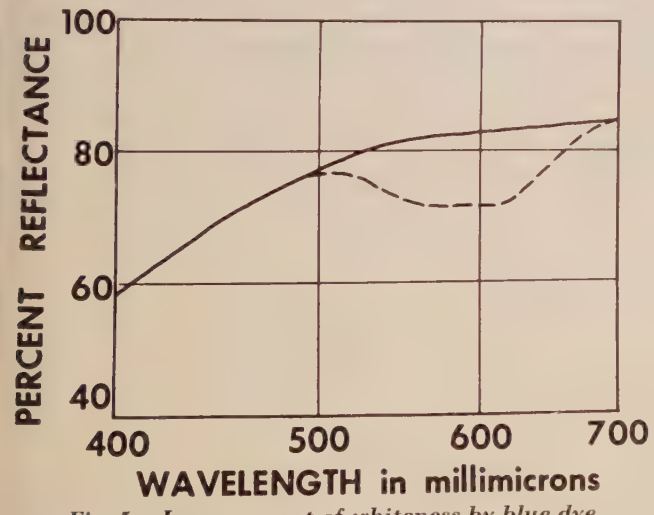

Fig. 5. Improvement of whiteness by blue dye

The solid curve shows the reflectance of an undyed paper. The dotted curve shows the reflectance of a paper to which 2.8 oz. of Helmerco Blue MGW Conc. per 1000 lb. of pulp have been added.

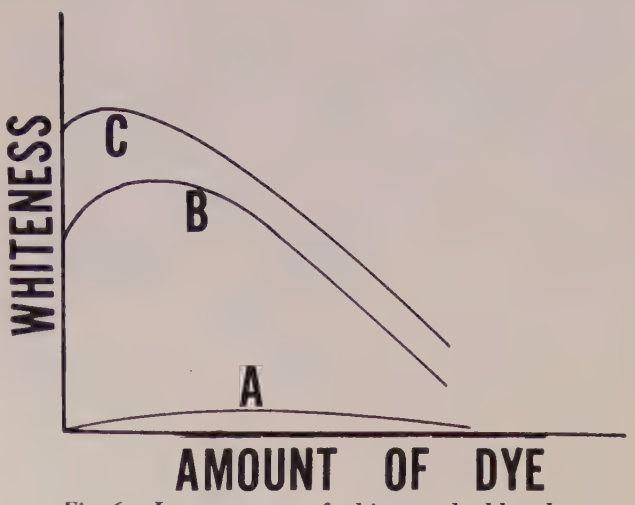

Fig. 6. Improvement of whiteness by blue dye

Curve A shows that the addition of blue dye to a stock of low brightness has very little effect on its whiteness. Curve B shows schematically that the whiteness of a stock of medium brightness is increased to an optimum concentration of blue dye and then is degraded rapidly as additional dye is added. Curve C shows that a stock which is very white to begin with can only be made slightly whiter by the addition of blue dye and the degradation of whiteness begins with very low concentrations of blue dye.

Addition of Fluorescent Whitening Agents

A fourth way to improve whiteness is to add one of the new fluorescent whitening agents. These compounds are dyes in that they have a definite substantivity to cellulose fibers, such as wood pulp, but they are colorless dyes. Indeed, they would be invisible except for the fact that they have a blue fluorescence. These dyes are able to absorb the ultraviolet component of white light which is particularly strong in daylight and convert this unseen portion of the spectrum to visible blue light. This visible blue light is just the right color to render neutral the slightly brown naturally reflected light of the paper stock. This effect is illustrated in Fig. 9 by spectrophotometric curves. In this one characteristic, namely, by rendering the reflected light neutral, the fluorescent whitening agents bring about a whitening of paper in the same way as do the blue dyes discussed above. There is, however, a very important difference in their action; whereas the blue dyes introduce neutrality by the absorption of light and the lowering of the over-all apparent reflectance, the fluorescent whitening agents bring about neutrality by the emission of light which increased the over-all apparent reflectance of the paper. These dyes, therefore, bring about whiteness by both of the established mechanisms.

The effect of increasing concentration is shown schematically in Fig. 10, curve B. This curve has been drawn to concentrations of fluorescent whitening agents far beyond the practical limits but it shows that the increasing concentration of these agents, which adds to the whiteness at first, may eventually detract slightly from the whiteness.

A stock of low brightness is very difficult to improve with a fluorescent whitening agent. The reason for this is that the ultraviolet light which is needed for activation of the fluorescent whitening agent is absorbed by the natural brown color of the stock. This effect is suggested by curve A of Fig. 10 which shows

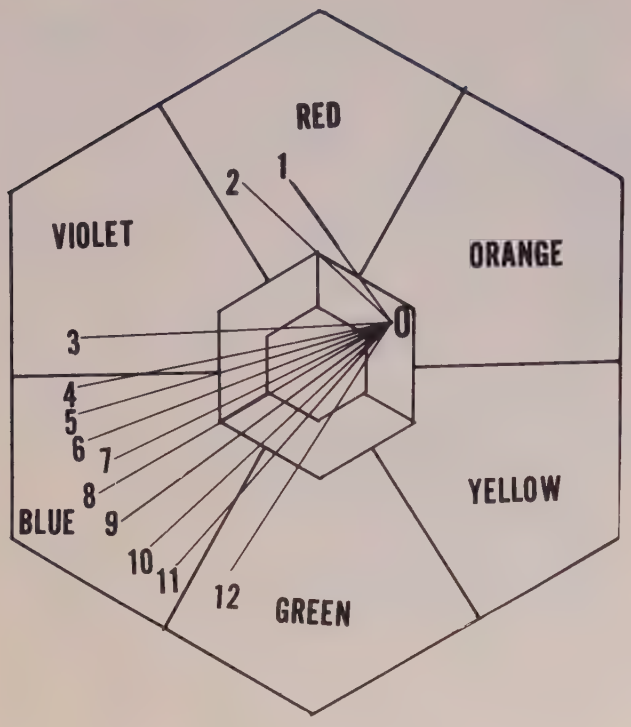

Fig. 7. Fast-to-light dyes useful for whitening paper

The 0 of the schematic color map represents undyed paper containing some small amounts of brown natural impurity. Points 1 to 12 represent various dyes. The lines connecting the 0 to the points representing the various dyes suggest the type of color change which is introduced by the addition of the various dyes.

practically no improvement to stock of low brightness as the result of the addition of fluorescent whitening agents. On the other hand, on stock of high brightness nearly all of the ultraviolet light is ultilized by the fluorescent whitening agent and it can have a very strong effect. This is suggested schematically by curve C of Fig. 10 which shows a big improvement in whiteness of the white stock.

An important characteristic of the effect of the addition of fluorescent whitening agents to stocks to improve whiteness is that it is most efficient on well-bleached stocks.

The two fluorescent whitening agents which are available, arranged in order of shade from a red shade to a green shade, follow in Table III:

Table III. Fluorescent Whitening Agents Which May Be Used to Whiten Paper

1.	Calcofluor ® White P3R
2.	Calcofluor White B

Addition of one of these to the paper stock will introduce a change toward neutrality as well as an increase in over-all apparent reflectance. This is illustrated by the color map of Fig. 11. The addition of Calcofluor White P3R will produce a color change along the lines of point 0 to point 1. This line falls on the pink side of neutral. On the other hand, the line from point 0 to point 2 suggests that the addition of Calcofluor White B will produce a white with a greener tint.

Comparison of Different Methods of Producing White

The first question which is likely to arise in the mind of a practical paper man is: What is the most economical way to produce paper of a required whiteness? It would be convenient if it could be stated that so many pounds of titanium dioxide were equivalent to so many pounds of blue dye which in turn were equivalent to so many pounds of fluorescent dye. Unfortunately, such a comparison is not feasible. As was discussed above, titanium dioxide has its most efficient action on stock of medium brightness, and the fluorescent dye has its most efficient action on stock of high brightness. Thus, if a cost comparison was made on stock of low brightness, there is no doubt that the titanium pigment would be by far the most economical. On stock of high brightness, no comparison can be made because no concentration of titanium dioxide and no concentration of blue dye can approach the whiteness which can be imparted by the fluorescent dye. The particular merits of each one of the four methods should be considered for the particular problem at hand.

The Evaluation of Brightness

The General Electric brightness meter or instruments of similar design, are widely used throughout the industry for the evaluation of paper. The readings from this instrument are called, quite properly, brightness values, not whiteness. This instrument was primarily designed for, and is ideally suited for, the measurement of brightness of natural stock. It relies on the single measurement of reflectivity as a measure of brightness. This is indicated schematically in Fig. 12 by a spectrophotometric curve. It works very well to evaluate the extent of chemical bleaching and to evaluate the effect of addition of white pigment, both of which induce brightness, and

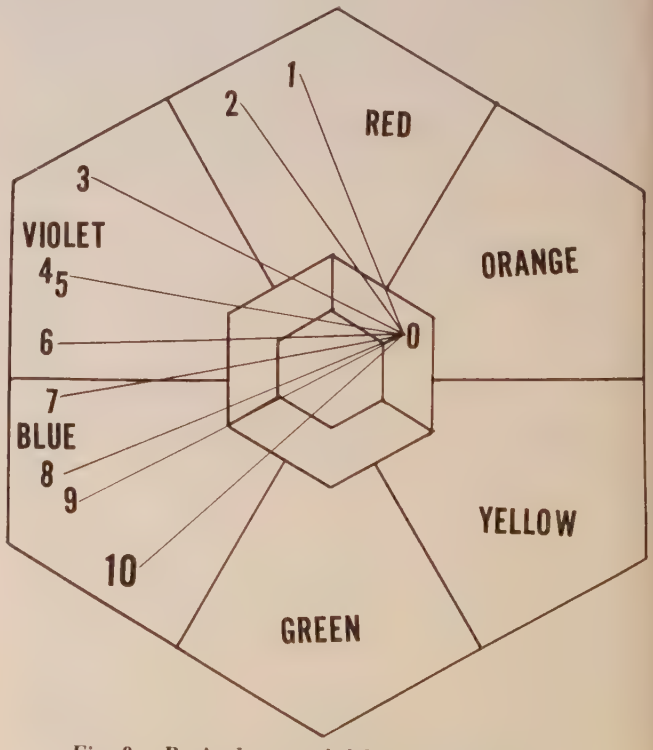

Fig. 8. Basic dyes useful for whitening paper

The 0 of the schematic color map represents undyed paper containing some small amounts of brown natural impurity. Points 1 to 10 represent various basic dyes. The lines connecting the 0 to the points representing the various dyes suggest the type of color change which is introduced by the addition of various dyes.

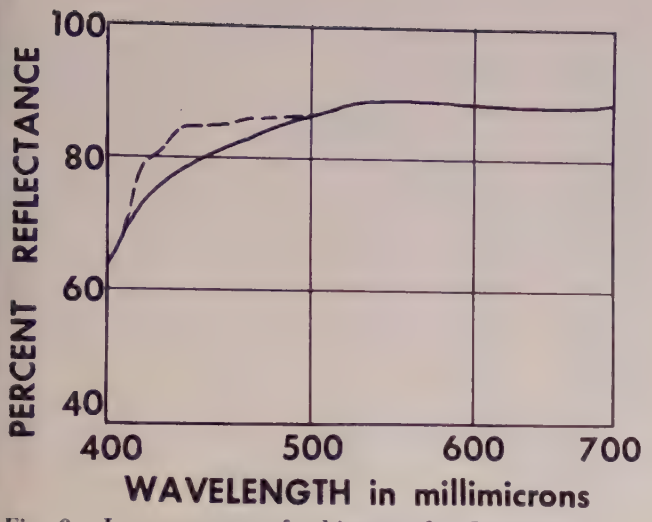

Fig. 9. Improvement of whiteness by fluorescent dyes

The solid curve shows schematically the reflectance curve of the undyed paper when illuminated by daylight. The dotted curve shows schematically the apparent reflectance curve of paper dyed with 2.5 lb. fluorescent dye (Calcofluor white P3R) per 1000 lb. pulp when illuminated by daylight.

incidentally whiteness, primarily by increasing reflectivity. On the other hand, it is not designed for, and is not suitable for, the measurement of whiteness induced by the addition of blue or fluorescent dyes. Both of these latter methods attain whiteness, at least in part, by the attainment of neutrality of reflected light, a characteristic which the General Electric brightness meter does not measure.

Evaluation of Whiteness with the Hunter Reflectometer

Methods of evaluation of whiteness have been discussed frequently in the literature (*2, 3, 5, 6, 7, 10*).

They depend fundamentally upon taking into consideration both the total reflectance and the departure from neutrality. This is indicated schematically in Fig. 13.

The formula most commonly used in this country is that of Judd (*6*).

$$W = 1 - \Delta E_{ws}/\Delta E_{wb} \qquad (1)$$

where W = whiteness index; ΔE_{ws} = the color difference between a magnesium oxide white and the sample; ΔE_{wb} = the color difference between the magnesium oxide white and theoretical black.

When the color difference formula proposed by Judd (*4, 6*) is solved for the color difference ΔE between a specimen of paper and the ideal magnesium oxide white the following equation results:

$$\Delta E = [K(1.00 - Y^{1/2})^2 + (7Y^{1/4}\sqrt{\alpha^2 + \beta^2}\ 0.10^2)^2]^{1/2} \qquad (2)$$

A pure black sample would have values of $Y = 0$, α and $\beta = 0$. Substituting these values in the above equation gives $\Delta E = K$. The equation for whiteness which has been proposed by Judd then becomes

$$W = 1 - \Delta E/K \qquad (3)$$

In equations (2) and (3), K is a factor which adjusts for the relative importance of "reflectance" and "departure from neutrality" or "tint." If K is made very large, "reflectance" is made very important whereas if K is made very small, the degree of "tint" becomes very important in evaluating the deviation from white. There is a good chance that the value of K will vary from one individual to another depending upon how importantly he weighs these two factors. The value of K will also vary depending upon the viewing conditions under which the comparisons of whiteness are made. Judd has found that the eye can detect difference of "tint"quite easily even if the two specimens are separated, whereas differences of "reflectance" are much more easily seen if the samples are closely adjacent. Thus, if the specimens are held very close together in judging whiteness visually, differences in "reflectance" become relatively important and K must be assigned a large number in order to weigh it properly.

Judd has found that if samples of white are judged some distance apart, K is 20. On the other hand, in the evaluation of some color differences where two samples are held very close together, the value of K may be as large as 120.

When 20 is substituted for K, and certain mathematical simplifications are introduced as described by Hunter (*1*), equation (3) becomes:

$$W = 1 - \left[(30\sqrt{\alpha^2 + \beta})^2 + \left(\frac{1.00 - Y}{2}\right)^2\right]^{1/2} \qquad (4)$$

Selling (*10*) tested the above equation with some white paper specimens during his study of the measurement of whiteness and found that 70 was a better value for K than was the 20 originally proposed by Judd. This difference arises from the fact that when the observers were evaluating whiteness in the Selling investigation, they held the comparative specimens close together for their evaluation. If 70 is used, the numerical coefficient 30 in equation (4) becomes 8.6. The exact value of the proximity factor K should be adjusted so as to get the best correlation with visual judgment of the color matcher whose work it is desired to predict by instrumental readings.

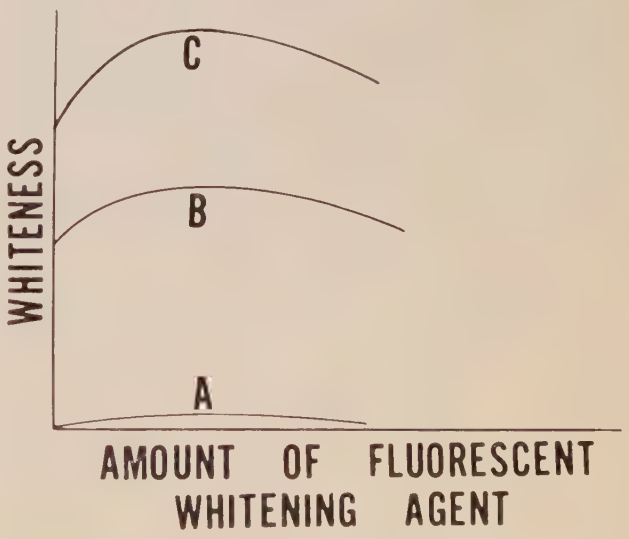

Fig. 10. Improvement of whiteness by fluorescent dyes

Curve A shows that the whiteness of stock of low brightness is essentially unchanged by any amount of fluorescent whitening agent. Curve B shows that a stock of medium brightness is improved somewhat by fluorescent whitening agents. Curve C shows that stock which is very white can be improved in whiteness by a fluorescent whitening agent to a greater degree than stocks of low brightness.

With the qualification that the value 30 is in some doubt and might better by 8.6, formula (4) is recommended for calculation of whiteness from data obtained with the Hunter reflectometer.

Evaluation of Whiteness from Spectrophotometric Data

The departure of the color of a specimen from pure white may be calculated with any of several small color difference formulas. Nickerson (*8*) has reviewed the small color difference formulas. She found that the correlation of results of all of the small difference formulas with visual observations showed no great advantage of one formula over another. Hence the formula to be selected for use in a particular case should depend upon the form of the color data. Thus, if the color data are in spectrophotometric terms, the "chromatic value" formula of Adams is most convenient. In this calculation, the tristimulus values are first converted to "chromatic value" by means of tables which have been published by Nickerson (*9*). When the Adams equation is solved for the color differences ΔE of a colored specimen from theoretical white, the following equation results:

$$\Delta E = 40\ [(0.23(10 - V_y))^2 + (V_x - V_y)^2 + (0.4\,(V_y - V_z))^2]^{1/2} \quad (5)$$

The factor 0.23 is the weighting factor that relates a difference in "reflectance" to a difference in "tint." However, it might be found that this factor should be made larger or smaller to get the best correlation with visual whiteness for a particular investigation. It is expected that this value should hold fairly well in whiteness comparisons when the samples are held in close proximity. Substitution of the Adams equation

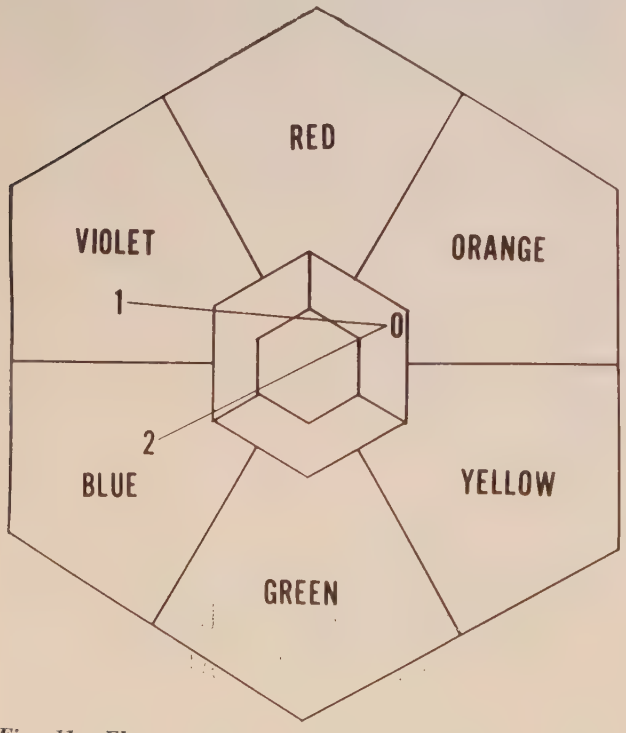

Fig. 11. Fluorescent dyes useful for whitening paper

The 0 of the schematic color map represents undyed paper containing some small amounts of brown natural impurity. Points 1 and 2 represent two fluorescent dyes. The lines connecting the 0 to the points representing the dyes suggest the type of color change which is introduced by the addition of the dyes.

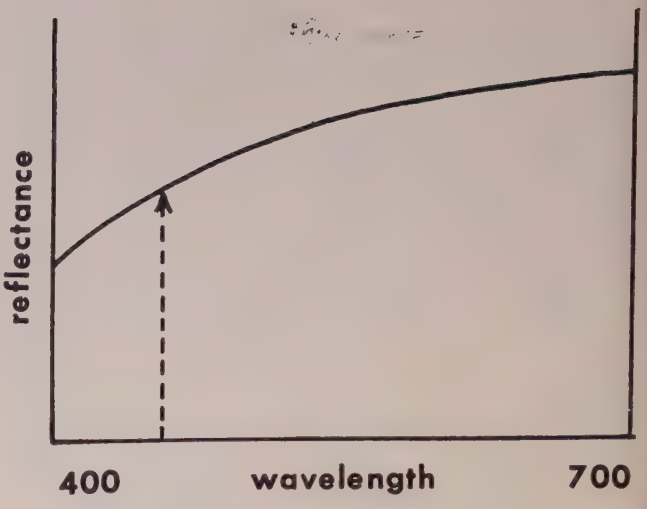

Fig. 12. Definition of brightness of a white

The curve shows schematically the reflectance of a white paper. The dotted arrow indicates that brightness is evaluated as the reflectance at a wavelength of 457 mu.

(5) in the Judd equation for whiteness (equation 1) gives the following:

$$W = 1 - 0.435[(0.23(10 - V_y))^2 + (V_x - V_y)^2 + (0.4(V_z - V_y))^2]^{1/2} \quad (6)$$

With the qualification that the value 0.23 might have to be changed to get best correlation between instrumental and visual judgements, formula (6) is recommended for calculation of whiteness from data obtained with a spectrophotometer.

Evaluation by means of equation (4) or (6) is limited to nonfluorescent samples for instrumental reasons and therefore does not apply directly to papers dyed with the fluorescent dye. There is no reason why the theory of these methods will not apply; it is only necessary to adjust the instrumentation so that the fluorescent light becomes an integral part of the measurement.

Any instrumental method would still be under the disadvantage that there is no universally accepted white; consequently, visual matching of a submitted standard or submission of a range of whites for selection by the ultimate user remains as the most practical answer to the problem of evaluating white on paper.

PART II—THE APPLICATION OF FLUORESCENT WHITES

In Part I the different methods of producing white on paper were considered. The remarks which were made, although quite general in nature, apply particularly to beater dyeing.

Three of the methods of producing whiteness, namely chemical bleaching, addition of white pigments and addition of blue dye have been widely used in the industry and require no special comment on application procedures. The fourth method, addition of fluorescent whites, requires the use of new products with which the paper colorist has had but little experience. Consequently, it was thought desirable to present the details of some laboratory tests which were carried out to determine the application properties of these dyes. These laboratory experiments will be of assistance in setting up mill trials. Part II is not limited to beater dyeing, but includes some work on application by simulated beater dyeing, coating, surface sizing, and calender staining.

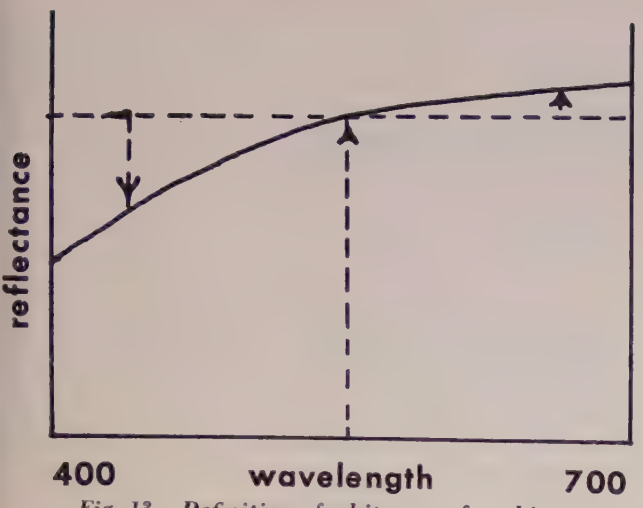

Fig. 13. Definition of whiteness of a white

The solid curve represents schematically the reflectance curve of a white paper. The central dotted line indicates that total reflectance is one factor contributing to the measure of whiteness. The horizontal dotted line and the two dotted arrows that show deviation of the solid curve from the horizontal line indicate that neutrality of color is a second factor in the evaluation of whiteness.

Laboratory Method to Simulate Beater Dyeing

In order to evaluate the effect of various factors on the efficiency of fluorescent white, a laboratory method of dyeing was adopted and variations on it were then made. Eight grams of bleached sulphite pulp were mixed with distilled water in a 600-ml. beaker to a consistency of 4%. With continuous stirring at 70°F., the following additions were made at 5-min. intervals: 0.01% of fluorescent white in water solution, 2% of a light rosin size, and 2.5% of alum. After additional stirring for 15 min., the pulp was diluted with distilled water to 0.5% consistency and half of it poured into a handmold to form a 4-gram sheet, 6 by 8 in. in size. This handmold consisted of a suction screen over which was placed a piece of wet filter paper. When formed, the sheet was pressed between felts by being passed through a wringer. After pressing, the underneath wet filter paper was replaced by a dry one, and then the specimen was dried for 7 min. on a 230°F. drum dryer. This gave a sheet which was considerably whiter than a similar sheet made without the fluorescent dye. It could be evaluated visually in daylight for whiteness or under the ultraviolet light to judge the intensity of fluorescence.

Variations in Dyeing

The following variations were studied:

1. Kind of Pulp. The fluorescent whites gave a good improvement in whiteness when applied to bleached sulphite, bleached suphate, bleached soda pulp, or white rag stock. Only slight improvement was found for unbleached sulphite and bleached groundwood. No improvement was observed for unbleached sulphate, unbleached groundwood, and unbleached sulphite glassine. In general, the whiter the stock, the more efficient is the dye.

2. Freeness. Normal variations in freeness had very little influence on the whiteness produced by the fluorescent dyes. However, in the case of extreme hydration, as represented by glassine stock, the whitening action of the dyes is reduced.

3. Hardness of Water. The hardness of the water used in the beater does not materially change the effectiveness of the dyes.

4. Metals in Water. The fluorescent whites react to a slight degree with lead and are slightly discolored by copper. These reactions are so slight that normally they would be of no consequence.

5. Temperature. A variation from 35 to 110°F. showed a slight increase in whiteness effect with the higher temperature but this effect was small.

6. Dyeing Time. A paper made from pulp dyed for 10 min. was no different in whiteness from one dyed for 75 min.

7. Solution and Dry Addition of Fluorescent Whites. There was no appreciable difference in sheets to which the white dye had been added as dry powder or in solution form up to concentrations of 3 lb. per ton. It is recommended that amounts in excess of this be dissolved in hot water before addition to the beater as otherwise some loss in effectiveness results.

8. Order of Addition. The best order of addition to attain whiteness was found to be dye, size, and alum. When dye and size or dye and alum were mixed first and added together, the result was poor because the dye is precipitated by either alum or rosin. Hence, it is best to give the fluorescent whites an opportunity to dye the cellulose fiber from a clear solution before the size and alum are added.

9. Amount of Rosin Size. The amount of rosin was varied from 0 to 6%. The dyes improved the whiteness of all the sheets but were most effective on the unsized sheets.

10. Color of Rosin. Fluorescent whites on unsized sheets showed the greatest improvement. Light color rosin-sized paper showed slightly less improvement and dark color rosin-sized paper showed still less.

11. Wax Size. With mixtures of rosin and Alwax® Size 200A the higher the proportion of wax size the better was the performance of the dyes.

12. Amount of Alum. The amout of alum was varied from 0 to 8%, keeping the amount of rosin constant at 2%. As the alum was increased from 0 to 2%, the efficiency of the fluorescent dyes was decreased, possibly because more rosin was precipitating on the wood fibers and rosin has a detrimental effect. Further increase in alum from 2% to 8% improved the efficiency possibly because less of the dye was left in the white water. Regardless of the amount of alum, all sheets showed substantial improvements in whiteness by the addition of the dyes.

13. pH. The pH of the water was changed over the range of 4.4 to 9.5 without changing the aluminum ion concentration by the substitution of alum with sodium aluminate. The improvement in whiteness was greatest at the high pH values.

14. Salt. The addition of 5% sodium chloride to the pulp after the dye was added gave a small (5%) improvement in fluorescence intensity.

15. Addition to Filled Papers. The best order of addition is as follows: dye, filler, rosin, and alum. Fillers such as clay, talc, calcium carbonate (with pH adjustment) zinc sulphide, and titanium dioxide all tend to decrease the effectiveness of the dyes but the dyes will give a definite increase in whiteness when used in filled papers. Of the filled papers studied, those

containing calcium carbonate were whitened the most by the addition of fluorescent whites.

16. Wet-Strength Resin. The action of fluorescent dyes is only slightly impaired by 1% of melamine resin (Parez Resin 607).

17. Blue "Whitening" Dye. The presence of small amounts of blue dyes is not completely additive to the whitening power of fluorescent whites. However, they are effectively used in combination.

18. White Water. In the recommended range of concentration, 1 to 4 lb. per ton, there should be no trouble from build-up in the white water, because the retention of the dye is good as is indicated by the following three experiments: (1) When the white water from one sized sheet was used to make the second, and the process repeated six times to duplicate a 100% closed white water system in a mill, there was very little difference in whiteness of the six successive sheets. (2) A second sheet was made in white water without adding any dye to the second sheet. This second sheet showed only 12% of the fluorescence of the first. (3) When a set of unsized sheets containing the dye at a high concentration was repulped in a Waring Blendor at 4% consistency, diluted to 0.5% consistency, and remade into sheets, there was about 40% loss of fluorescence intensity.

At concentrations below 7 lb. per ton, the retention of the dye is about the same for sized and unsized sheets. At concentrations in the range of 7 to 12 lb. per ton, the retention is much greater in the presence of size. At concentrations in excess of 12 lb. per ton, the solubility of the dye in the beater may be exceeded. Concentrations in the range of 1 to 4 lb. per ton are considered practical.

Coating

This method of application was studied somewhat. A casein adhesive was prepared by heating a mixture of 500 grams of casein and 2000 ml. of water to 110°F., then adding 80 grams of borax dissolved in 500 ml. of water. This was stirred during the 2 hr. and then strained. After straining, 60 ml. of concentrated ammonia were added and the stirring continued for several hours. A dye solution was made up having a strength of 0.25% in water. The coating mixture consisted of 50 grams of H.T. clay, 50 grams of casein adhesive, 50 ml. of the fluorescent dye solution. These were mixed, strained through a fine mesh screen, and drawn down on paper with a drawdown coating rod. The coatings were then air dried and pressed on a hydraulic press. The dye gave a small increase in the whiteness of the pigmented coatings.

Variations in Coating

1. Adhesive. Some whitening action was observed in starch, latex, and polyvinyl alcohol.

2. Pigment. The whitening action was better with clay as the pigment than with titanium dioxide.

Surface Sizing

This method of application was demonstrated to be useful but not many variations were investigated. For the standard method some slack-sized sheets were prepared from bleached sulphite pulp with a freeness of 650 S.-R. having 0.25% of rosin and 0.5% alum. The adhesive was mixed with 0.25% dye. The adhesive was then applied to the sheet with a laboratory calender staining roll. The increase of whiteness was very noticeable.

Variations in Surface Sizing

1. Adhesive. It was found that a 5% solution of gelatin (hide glue) was slightly inferior to either a 3% solution of imported Dutch superior potato starch or a 5 or a 10% solution of Douglas Clearsol Gum. These latter two were equivalent.

2. Concentration of Dye. It was found that the dye would not stay in solution in much higher concentrations than 0.25% unless the temperature was kept at 140°F. The sheets made from the surface size containing fluorescent white that had precipitated out of solution had a streaked and unsatisfactory appearance.

Calender Staining

This method of application was demonstrated to be useful. A staining solution was made up of water containing an appropriate wetting agent to which was added 0.5% dye. This solution was applied in a laboratory staining machine to a bleached slack-sized sheet containing 0.25% rosin and 0.5% alum. The stain gives a good improvement in whiteness. If the dye does not penetrate into the sheet but remains only on the surface it is often much less efficient in whitening paper. The penetration may be improved by adding ethyl alcohol, acetone, or wetting agent, or by raising the temperature of the staining solution to between 120 and 140°F. The solubility of the fluorescent whites is low in either alcohol or water, thus, care should be taken in preparing and storing the solution. In general, solutions containing 0.1% dye are quite stable under all conditions. Higher concentrations may be used if the solutions are kept warm.

Fastness of Fluorescent Whites

Storage. Sheets kept in a pile for a month showed no change in fluorescence intensity or whiteness.

Light. Sheets exposed to light in a Fade-Ometer showed some loss of fluorescence strength in 3 hr. and nearly complete loss in 20 hr.

Evaluation of Paper Treated with Fluorescent White

Daylight. The whiteness of papers treated with fluorescent whites shows up to best advantage when examined in daylight. They also show up well under fluorescent lights, and still show some advantage under incandescent lights.

LITERATURE CITED

1. Hunter, R. S., "Photoelectric Tristimulus Colorimetry with 3 Filters," Circular C-429, National Bureau of Standards (1942).
2. Judd, D. B., *Tech. Assoc. Papers*—Series XVIII, No. 1, 392 (1935).
3. Judd, D. B., *Tech. Assoc. Papers*—Series XIX, No. 1, 359 (1936).
4. Judd, D. B., *Textile Res.* 9, 253 (1939).
5. Judd, D. B., *J. Am. Optical Soc.* 31, 462 (1941).
6. Judd, D. B., "Colorimetry," Circular 478, National Bureau of Standards, March, 1950.
7. MacAdam, D. L., *J. Am. Optical Soc.* 24, 188 (1934).
8. Nickerson, D., *Tech. Assoc. Papers*—Series XXX, 472 (1947).
9. Nickerson, D., *Am. Dyestuff Reporter* vol. 39, pp. 541–546, Aug. 25, 1950.
10. Selling, H. J., *Appl. Sci. Res.* B1, 453 (1950).
11. Sundstrom, F. O., and Stearns, E. I., *Paper Trade J.* 131, No. 2: 24 (1950).
12. TAPPI "Brightness of Paper" Official Standard T 452 m-48.

A Contribution of the Application Research Dept., Calco Chemical Div. American Cyanamide Co., Bound Brook, N. J.

Straw Pulp-Wood Pulp Blends for Various Types of Papers

S. I. ARNOVOSKY, A. J. ERNST, R. J. SEIDL, and R. M. KINGSBURY

Illinois combined wheat straw was pulped by the mechano-chemical process, bleached, and blended with Lake States wood pulps to produce typical magazine, book, newsprint, bond, bag, waxing, and greaseproof papers on an experimental fourdrinier paper machine. Control runs were made using wood pulps only. The inclusion of straw pulp in these paper furnishes resulted in improved formation, bursting and tensile strength, and folding endurance. The tearing resistance of the straw-containing papers was somewhat lower than that of the controls, but the reduction in tear was relatively small. It is evident from these preliminary data that straw pulp could be used to good advantage in improving many types of specialty papers.

CEREAL grain straw is a very important raw material for the production of paper and board and their products in Europe and South America. Some of the highest grades of fine specialty papers produced in these countries contain more than 75% straw pulp. In Europe, particularly in Italy, the Netherlands, and France, and in the Argentine, some of the highest grade papers including safety, bond, writing, and glassine papers contain large proportions of straw pulp. A high-grade glassine or greaseproof paper is made in Italy from a furnish consisting almost entirely of bleached straw pulp, while in the Argentine, straw pulp is included in the furnish of most papers and has about the same degree of universality for paper manufacture there as groundwood has in the United States.

The role of straw pulp in paper is more than merely one of filler. It provides certain characteristics in the finished paper or board which cannot be so well or so easily obtained from other types of fibers. Papers containing straw pulp usually have better and more uniform formation and smoother surfaces as well as a more uniform although slightly higher density than papers produced from wood pulps. On account of their generally high hemicellulose contents the straw pulps hydrate more easily and thus require less power for hydration and refining. This relative ease of hydration, and the fact that the straw fibers swell readily, results in beaten fibers with little or no fibrillation, since the maximum degree of hydration is reached before the straw fibers are bruised to any large extent by mechanical refining. Because the individual straw fiber has an extremely small diameter, its ratio of length to diameter is higher than that of most coniferous and deciduous wood pulps, even though the straw fiber is relatively short with an average length about equal to that of deciduous wood fiber. This high length-to-diameter ratio produces excellent felting and formation characteristics on the paper machine wire, and results in paper with relatively high bursting, tensile, and folding strengths. The tear resistance of the straw papers is generally somewhat lower than that of papers made from coniferous wood pulps, since tear resistance is more or less directly related to length of the constituent fibers.

In the United States the cereal grain straws are used at present only for the production of corrugating paper. Only about 400,000 to 500,000 tons of straw is used for this purpose, although an estimated 30 million tons is available annually for industrial use. In recent years, however, and particularly in the last 2 or 3 yrs. a considerable amount of interest has been shown by the pulp and paper industry in the United States in the possibilities of straw as a continued supplemental source of raw material for its products. In early 1951, a West Coast pulp and paper manufacturer became sufficiently interested to make some experimental papermaking trials from blends of western wheat straw pulps with western wood pulps. The results of these trials, as yet unpublished, were quite encouraging. The addition of straw to wood pulp furnishes produced papers with improved formation and surface texture and higher bursting strength. It was also observed in the experimental runs that the improvements due to straw pulp were more pronounced when this pulp was hydrated before addition to the furnish.

Based on those results, it was decided to make some further trials with wheat straw from the Middle West and wood pulps produced in the Lake States area. The straw pulp for this work was prepared by the mechano-chemical process at the Northern Regional Research Laboratory. This pulp was bleached in the pilot-plant equipment of the Forest Products Laboratory, and the paper was made on its experimental fourdrinier paper machine.

EXPERIMENTAL

Straw Pulp

The straw selected for this study was a soft winter wheat variety (Kawvale) grown in 1945 near Chillicothe, Ill. The straw had been combine-harvested, and baled in the normal commercial manner. At the Northern Laboratory, the straw was chopped to 1 to 4-in. lengths in a silage cutter, and the cut straw was dusted over a 20-mesh vibrating screen. The material removed in this dusting operation amounted to 2 to 3% of the weight of the original straw and consisted almost entirely of dirt with only a very small amount of straw fines.

The chopped, dusted straw was cooked in a 3-ft. stainless-steel Hydrapulper with 12% caustic soda, basis oven-dry straw, for 35 min. at 95 to 98°C. In this pulping operation, the water and chemical were heated in the Hydrapulper and the straw was then

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charged as rapidly as possible, the time of charging usually being less than 5 min. The ratio of total liquid to straw at the beginning of the cook was approximately 9 to 1. The consistency at the end of the pulping cycle was reduced to about 6%, due to solution of some of the straw material and dilution by direct steam used to maintain the pulping temperature. At the end of the pulping period, the cooked straw was

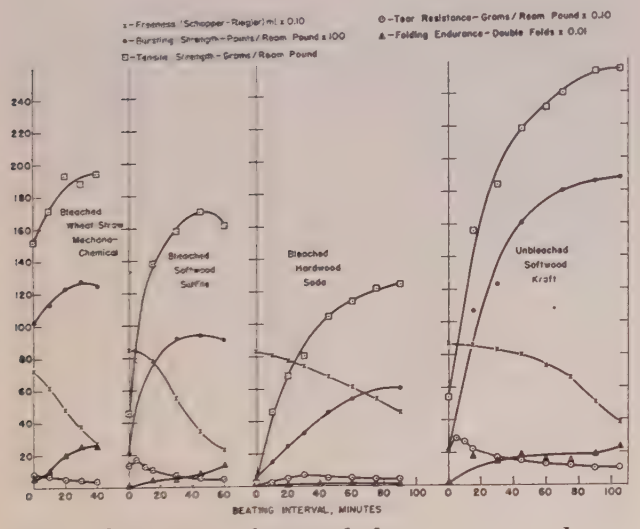

Fig. 1. Comparison of strength data on straw and commercial wood pulps

removed and washed with water by gravity displacement. The washed material was returned to the Hydrapulper and circulated at a consistency of 6 to 7% for about 15 min. in order to obtain additional defibering without further cooking. The defibered straw pulp was diluted to about 0.35% consistency, run over a 10-ft. long, laboratory-made riffler and discharged onto a 2-plate flat screen fitted with 8-cut plates. (The nodes and rachises (heads), which were softened and swollen but not cooked or defibered in this mild pulping operation, were trapped in the riffler and on the screen. Thus, the main sources of the fine platelets and cells in the straw are eliminated from the accepted pulp, resulting in a product which had considerably improved drainage characteristics.) The screened pulp was thickened by running it over a 80-mesh inclined screen saveall. The white water draining from the saveall was used for diluting the straw pulp going to the riffler.

The average yields in these cooks were: crude pulp, 63.0%; screened pulp, 53.6%; rifflings, 2.0%; screenings, 2.7%; fines (by difference), 4.7%.

Since only about 25 lb. of screened pulp could be obtained per cook, 12 individual cooks were made to produce the 300 lb. (dry basis) of straw pulp which was shipped to the Forest Products Laboratory. The pulp from each individual cook was pressed to a moisture content of approximately 25% on a 4-ft. board machine prior to shipping. A preservative (lignasan) was added to the pulp at the Northern Laboratory.

At the Forest Products Laboratory, the straw pulp was disintegrated in a beater (with the roll raised from the bed plate), blended in a stock chest and thickened, without screening, on an experimental wet machine. About 225 lb. of this pulp was bleached and the remainder was used in the unbleached condition.

Bleaching was carried out in the pilot-plant equipment of the Forest Products Laboratory in a three-stage operation, involving chlorination, alkaline extraction, and hypochlorite bleaching. The chlorination was done in a rubber-lined chlorinator fitted with shrouded impellers. A weighed quantity of liquid chlorine was passed through an evaporator and the gas was injected into the pulp through a Saran pipe near the bottom of the chlorinator. The consistency in the chlorinator was 3.7%, and the pH was 1.5. The temperature during chlorination was 25°C. and the 7.1% chlorine (basis dry pulp) applied was practically exhausted in 60 min. The chlorinated pulp was diluted and pumped over a vacuum washer. The washed and thickened pulp was discharged into the extraction tower where circulation of the stock and mixing with chemical were obtained by means of a stationary draft tube, enclosing a screw with a sweep arm at the bottom.

The extraction was carried out with 2% sodium hydroxide (basis dry unbleached pulp) for 30 min. at 80°C. The consistency during this operation was 12.2% and the pH was kept at 11.0 to 11.2. Heating was accomplished with direct steam admitted at the top of the vessel. After extraction, the pulp was again diluted, washed on the vacuum washer, and returned to the same reaction tower for hypochlorite bleaching.

The final bleaching stage was accomplished with 1.6% available chlorine, as hypochlorite, based on dry pulp. The chlorine was practically exhausted after circulation for 150 min. at 35°C. and a consistency of 11.1%. The pH of the mixture was maintained between 8.5 and 9.2.

The total chlorine consumption, basis unbleached pulp, was 8.7% and the brightness of the final pulp was 82.4 as measured on the Hunter reflectometer. The yield of bleached pulp was about 84% of the unbleached material; this low yield was due mainly to excessive loss of fines in the larger operation since small-scale bleaching trials had indicated a bleached yield of about 90%.

Wood Pulps

The following wood pulps produced in the Lake States area were available at the Forest Products Laboratory: (1) unbleached kraft pulp from northern pinewood, machine dried prior to shipment. It had a Canadian Standard (C.S.) freeness of 775 ml.; (2) unbleached groundwood in wet lap form, from 60% spruce and 40% aspen wood, with a freeness of 140 ml. C.S.; (3) bleached sulphite pulp from 100% sprucewood, originally received in wet lap form but air dried by the time it was used. The pulp had a freeness of 735 ml. C.S.; (4) bleached soda pulp from aspen wood, machine dried prior to shipment, with a freeness of 550 ml.; (5) waste news as unprinted standard newsprint from a Madison, Wis., newspaper.

The TAPPI beater test curves for the straw and wood pulps are shown in Fig. 1. It is evident from these data that the strength characteristics of the bleached straw pulp are superior to those of the bleached sulphite wood pulp except in tearing resistance. The straw pulp, however, was inferior to the unbleached kraft wood pulp in all strength properties except in fold-

Table I. Data on Papers Containing Bleached Straw Pulp

Machine run No.	Pulp furnish: Bleached straw soda, %	Unbleached groundwood, %	Bleached sulphite, %	Waste news, %	Bleached soda, %	Jordan-vau pressure (gage), lb.	Stock Headbox freeness: Schopper-Riegler, ml.	Canadian Standard, ml.	Basis weight, 25 × 38—500, lb.	Thickness, mils	Density, gm./cc.	Bursting strength, pt./lb./rm.	Average tearing resistance, gm./lb./rm.	Sheet properties: Average tensile strength, p.s.i.	Average folding endurance, double folds	Air resistance (Gurley) sec./100 cc.	Smoothness (Bekk), sec.	Brightness, G.E. equiv.	Gloss, %	Opacity, %	Castor oil penetration, sec.	Size No.	Ash content, %
Magazine Coating Base Paper: 32-Lb. Basis Weight (25 × 38—500)[a]																							
3473	..	60	40	..	..	5	..	..	33.1	2.5	0.73	0.24	0.77	6.8	3	22	44.4	68.9	..	..	..	..	5.5
3474	25	60	15	..	..	5	305	140	32.8	2.7	0.67	0.33	0.64	9.4	8	47	15.5	67.8	..	..	..	..	6.4
Newsprint Paper: 32-Lb. Basis Weight (24 × 36—500)[b]																							
3475	..	..	20	80	..	0	470	185	37.2	2.8	0.73	0.25	0.73	8.5	5	27	34.2	61.1	40	89	39	0.40	1.8
3476	20	..	..	80	..	0	405	145	37.8	3.0	0.71	0.26	0.61	10.4	7	56	20.3	61.9	36	88	69	0.28	2.6
Soda Book Paper: 50-Lb. Basis Weight (25 × 38—500)[c]																							
3477	..	..	50	..	50	12	625	280	53.0	3.1	0.95	0.17	0.63	8.7	1	49	81.4	81.1	34	92	49	0.93	17.2
3478	50	..	20	..	50	0	575	230	50.1	2.8	0.99	0.23	0.70	10.2	3	76	109.2	81.5	36	91	65	1.08	16.5
Bond Paper: 20-Lb. Basis Weight (17 × 22—500)[d]																							
3479	..	..	100	..	..	0	675	345	54.2	3.7	0.81	0.30	1.17	14.4	12	23	14.6	79.5	28	86	58	0.93	7.4
3480	60	..	40	..	..	0	410	145	54.6	3.4	0.89	0.51	0.83	20.9	55	199	8.1	81.0	28	83	203	1.43	8.4
Bleached Waxing Paper: 30-Lb. Basis Weight (24 × 36—500)[e]																							
3481	..	..	100	..	..	0	585	285	34.8	2.1	0.92	0.46	0.75	13.8	24	28	36.9	..	34	69	35	0.82	..
3482	50	..	50	..	..	0	335	200	35.1	2.2	0.87	0.62	0.67	17.5	131	88	24.2	..	35	64	59	1.18	..
Greaseproof Paper: 30-Lb. Basis Weight (25 × 40—500)																							
3486	75	..	25	..	..	0	110	..	29.5	1.7	0.96	0.81	0.38	18.4	2854	+7320	..	..	..	..	+1800 (Turpentine)	..	..

[a] Furnishes include 7.0% Whitex clay.
[b] Furnishes include 3.0% Whitex clay and 0.25% rosin size.
[c] Furnishes include 25% Whitex clay and 2% rosin size.
[d] Furnishes include 10% Whitex clay and 1.5% rosin size.
[e] Furnishes include 1% rosin size.

ing endurance. In comparison with the bleached soda hardwood pulp, with fibers of approximately the same length, the straw pulp is far stronger in all properties. A most important property of straw pulp—its ease of hydration—is strikingly illustrated by the relatively short beating time required to bring out the optimum strength characteristics of this pulp.

PAPERMAKING TRIALS

The straw pulps were blended with the wood pulps and used in the furnishes of magazine, book, newsprint, bond, bag, waxing, and greaseproof papers. The pulps for the various papermaking experiments were processed in a 50 or 100-lb. beater and run over the experimental 13-in. fourdrinier paper machine.

The wood pulps for the controls and for the blends were beaten, in accordance with experience at the Forest Products Laboratory, to the degree required for each particular type of paper. The straw pulp was beaten in all cases to a C.S. freeness of about 190 ml. (500 ml. Schopper-Riegler (S.-R.)). The straw pulp was beaten to this degree because previous experience had indicated that unbeaten straw pulp acted mainly as filler, with no marked effects on the strength values of the resulting papers.

The pH of the various stocks in the beaters was adjusted to 7.0 with sulphuric acid after beating but prior to addition of size, filler, and so on, to offset the effect of the relatively high alkalinity of the Madison, Wis., water. After beating and addition of the sizing and filling materials, the pH value of the furnish was lowered to 5.5 with alum. This value was also maintained in the dilution water and in the machine headbox by the addition of alum.

The wet end of the machine is shown in Fig. 2 and the calender stack and winder in Fig. 3.

The conventional physical tests were made on these experimental papers in accordance with TAPPI standard methods, and the results are given in Tables I and II, and illustrated in Figs. 4, 5, and 6.

Magazine Coating Base Paper Series: 32-lb. Basis Weight (25 × 38—500)

The control run (3473) consisted of a furnish of 60% groundwood and 40% bleached sulphite pulps. The pulps were blended but not beaten. For run 3474, 25% bleached straw pulp was used to replace part of the bleached sulphite, resulting in a furnish of 60% groundwood, 15% sulphite, and 25% straw pulps. The straw pulp was beaten to a freeness of 180 ml. C.S., and then the groundwood and sulphite pulps were mixed in with no further beating. Seven per cent clay was added to the

furnish. A light jordan treatment was used in these runs and both papers were calendered through the three bottom nips of the seven-roll stack.

The use of the beaten straw pulp in the furnish resulted in an increase of about 40% in bursting and tensile strength and a decrease of about 17% in tearing resistance as shown in Table I. The formation was improved by the presence of the straw pulp, but the surfaces of the straw-containing paper were not as smooth as those of the all-wood pulp paper as evidenced by value obtained with Bekk smoothness tester. This is in contradiction to experience with commercial

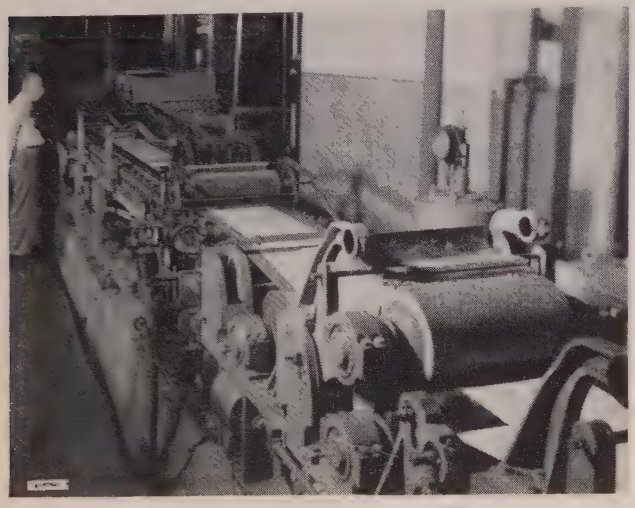

Fig. 2. The wet end of the experimental 13-in. width fourdrinier paper machine making straw paper

straw-containing papers which generally have smoother surfaces than the corresponding all-wood papers. In a commercial trial in a large Canadian newsprint mill in 1948, where 17 to 20% of straw pulp was incorporated into the regular newsprint furnish, the resulting paper had better formation and smoother surfaces than the paper made from the standard sulphite-groundwood furnish. It appears, therefore, that the surface characteristics of these experimental papers could be improved considerably by the heavier calendering available with commercial paper machines.

Newsprint Paper Series: 32-Lb. Basis Weight (24 × 36—500)

In this series, the control (3475) consisted of a furnish of 80% commercial unprinted newspaper and 20% bleached sulphite. The two pulps were blended but not beaten. They were slushed for nearly an hour to thoroughly disintegrate the newspaper. In run 3476, bleached straw pulp replaced the sulphite, resulting in a furnish of 80% waste newspaper and 20% straw pulp. The straw pulp was beaten prior to the addition of the news, and the mixture was slushed for 1 hr. with no further beating. Three per cent clay filler and 0.25% rosin size, based on oven-dry fiber, were added. No jordaning was used in this series. The sheets were passed through all six nips of the calender, with moderate additional pressure in the pneumatic lever system.

The formation of the sheet was improved by inclusion of the straw pulp but the surface smoothness was somewhat lower than that obtained with the sulphite pulp. The formation of both papers was better than found with typical standard newsprint paper. The straw-containing paper was not as porous as the control and had a higher castor oil penetration value. The use of beaten straw pulp gave only a slight improvement in bursting strength but increased the tensile strength from 8.5 to 10.4 lb. per in. width (Table I). The general surface characteristics of these newsprint papers indicated that additional calendering, preferably with higher moisture content in the sheet going to the calenders, would result in considerable improvement.

Soda Book Paper Series: 50-Lb. Basis Weight (25 × 38—500)

Bleached straw pulp was used in this series with the idea of improving formation and surface smoothness. The control run 3477 consisted of 50% bleached hardwood soda, and 50% bleached sulphite pulps. The sulphite was beaten separately to a freeness of 430 ml. C.S. and the soda was then added with no further beating. In run 3478 the furnish consisted of 30% bleached straw, 50% soda, and 20% sulphite pulps. The straw pulp was beaten to a freeness of 180 ml. C.S., and the sulphite was beaten separately to a freeness of 510 ml. C.S. The beaten straw and sulphite pulps were then mixed with the unbeaten soda pulp. Two per cent rosin size and 25% clay were added, and the system adjusted to a pH of 5.5 with alum. The control run was jordaned, but in the run containing straw pulp no jordaning was used. All six nips of the calender were

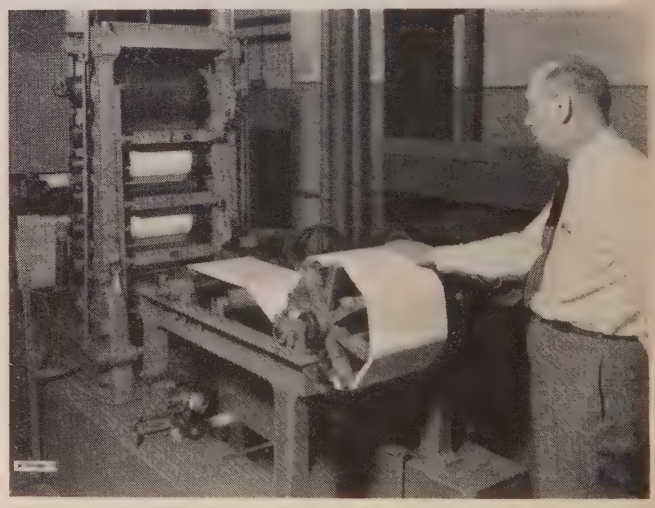

Fig. 3. The calender stack and winder of the paper machine

used, with additional pressure added through the pneumatic lever system.

The straw-containing book paper had better bursting and tensile strength and better tearing resistance than the control paper. The paper containing the straw pulp was smoother than the control, and it also had a higher castor oil penetration value. The ash contents of these two papers were approximately the same, 17.2% for the control and 16.5% for the straw-containing paper (Table I).

Bond Paper Series: 20-Lb. Basis Weight (17 × 22—500)

The furnish for the control run, 3479, was 100% bleached sulphite beaten to a freeness of 510 ml. C.S.

In run 3480 the furnish consisted of 60% bleached straw pulp and 40% bleached sulphite pulp. The straw and sulphite pulps were beaten separately to freenesses of 185 and 590 ml. C.S., respectively, and then blended. Ten per cent clay filler and 1.5% rosin size were added to the furnish. No jordaning was used in either run. The papers were passed through the lowest nip of the calender stack with the normal pressure equivalent to the weight of the upper six rolls.

The data obtained on these bond papers indicated a considerable increase in bursting strength, tensile strength, air resistance, and castor oil penetration, with some reduction in tear resistance, by inclusion of a substantial amount of straw pulp in the furnish, as shown in Table I. The formation of the straw-containing paper was considerably better than that of the control. The straw-containing paper showed some evidence of "cockling"; this could probably have been eliminated by machine adjustments had a longer run been possible.

Bleached Waxing Paper Series: 30-Lb. Basis Weight (24 × 36—500)

The control run was made with bleached sulphite pulp beaten to a freeness of 485 ml. C.S. In run 3482

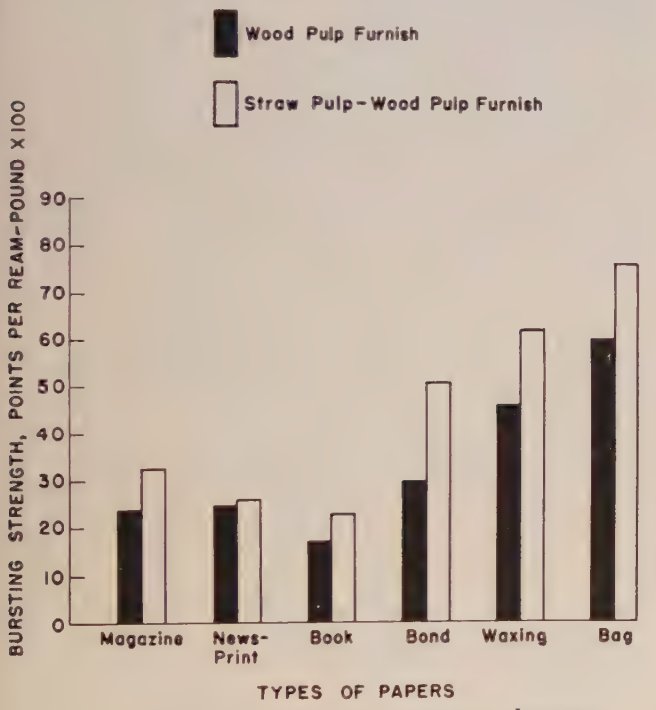

Fig. 4. Bursting strength of experimental papers

straw pulp replaced half of the sulphite pulp, with the straw pulp beaten to a freeness of 190 ml. C.S., and the sulphite pulp to 580 ml. C.S. before blending. One per cent rosin size was added to the furnish. No jordaning was used. The papers were passed through all six nips of the calender, with moderate additional pressure applied through the pneumatic lever system.

The use of the straw pulp increased the bursting strength from 0.46 to 0.62 pt. per lb. per ream, and the tensile strength from 13.8 to 17.5 lb. per in. width, while it decreased the tearing resistance from 0.75 to 0.67 gram per lb. per ream (Table I). The straw-containing paper had better formation and finish and appeared to be more transparent than the control. Based on the strength properties and visual appearance of this sheet, it seemed to have the proper characteristics for waxing stock.

Kraft Bag Paper Series: 50-Lb. Basis Weight (24 × 36—500)

An all-wood unbleached kraft furnish was used for the control run (3484). The pulp was beaten to a C.S. freeness of 600 ml., 1.5% size based on fiber was added, and the system adjusted to a pH of 5.5 with

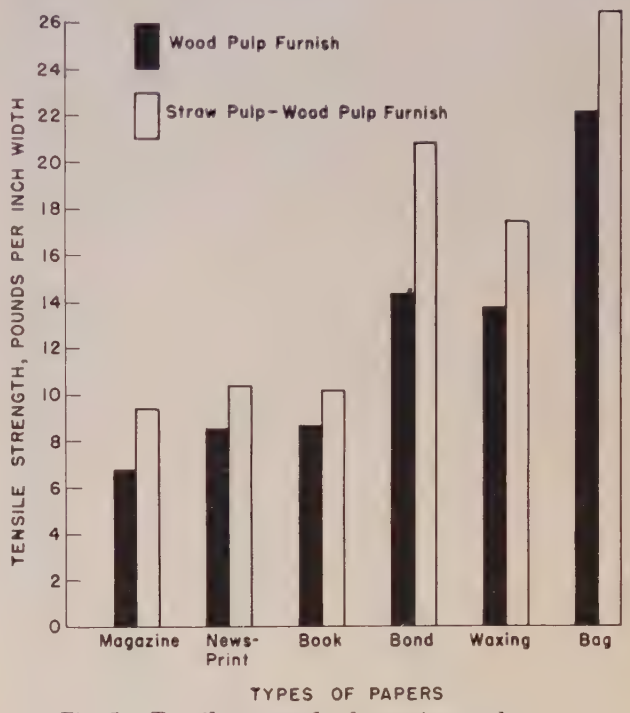

Fig. 5. Tensile strength of experimental papers

alum. In run 3485 the furnish consisted of 25% unbleached straw pulp and 75% of the unbleached kraft pulp. The two pulps were beaten separately, the straw for 35 min. to a freeness of 180 ml. C.S., and the kraft for 110 min. to a freeness of 600 ml. C.S. One per cent rosin size was added to the straw portion, and 1.5% to the kraft pulp. The pH of the blended pulps was adjusted to 5.5 with alum. Both the kraft furnish and the straw-containing stock were given light jordaning treatments.

The formation and surface texture of the paper were improved by the addition of straw pulp. While the bursting strength of the straw-containing paper was about 30% higher and the tensile strength about 20% higher than those of the all-kraft paper, the reduction in tear resistance by addition of the straw pulp was only about 15% (Table II). The folding endurance of the straw-containing paper was higher than that of the control. The straw-containing paper had the appearance of an excellent bag paper, and still had adequate tear resistance.

Greaseproof Paper Series: 30-Lb. Basis Weight (25 × 40—500)

The furnish for the greaseproof paper consisted of 75% bleached straw and 25% bleached sulphite pulps.

Table II. Properties of Kraft Bag Papers Containing Straw Pulp

Machine run No.	Pulps: Pulp furnish: Unbleached straw pulp, %	Pulps: Pulp furnish: Unbleached sulphate pulp, %	Stock: Jordaning pressure lb.	Stock: Headbox freeness: Schopper-Riegler, ml.	Stock: Headbox freeness: Canadian Standard, ml.	Sheet properties: Basis weight, 25 × 40—500, lb.	Sheet properties: Thickness, mils	Sheet properties: Density, gm./cc.	Sheet properties: Bursting strength, pt./lb./rm.	Sheet properties: Average tearing resistance, gm./lb./rm.	Sheet properties: Average tensile strength, p.i.w.	Sheet properties: Average folding endurance, double folds
3484[a]	...	100	15	750	480	50.4	3.7	0.75	0.60	1.41	22.2	128
3485[b]	25	75	10	670	345	50.5	3.5	0.80	0.76	1.22	26.5	224

[a] Furnish includes 1.5% rosin size.
[b] Furnish includes 1.5% rosin size on kraft portion and 1% on straw portion.

The first trial (3483), in which the pulps were beaten together for 2.75 hr. to a Schopper-Riegler freeness of 100 ml. was unsuccessful because the wet web, apparently due to the slow drainage rate of the stock, could not be removed from the wire.

In run 3486, the pulps were beaten together for 1.75 hr. to a S.-R. freeness of 210 ml. The pH of the system was adjusted to 5.5 with alum. No jordaning was used in this run. The paper was passed through the bottom nip of the calender with the pressure equivalent to the weight of the upper six rolls.

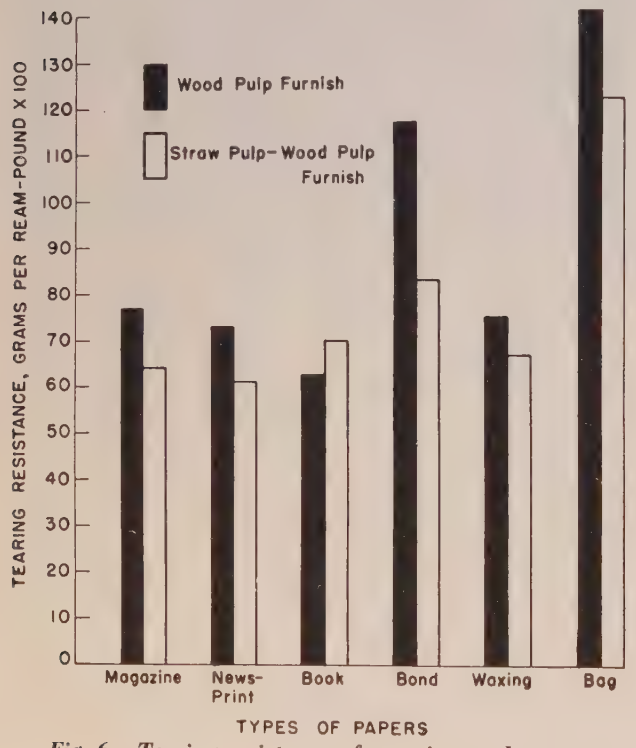

Fig. 6. Tearing resistance of experimental papers

The sheet had drainage characteristics typical of a greaseproof stock. The paper showed a favorable blister test for greaseproofness and was definitely promising of meeting the other requirements for such papers as seen from the data in Table I.

GENERAL CONSIDERATIONS

It is evident from the results of these paper-machine trials that the inclusion of straw pulp in the furnishes produced the various types of papers with generally improved properties. The use of straw pulp improved the bursting strength in all of the types of paper made, as shown in Fig. 4. In the same way the tensile strength of all the straw-containing papers was greater than that of the controls (Fig. 5). The tearing resistance of the straw-containing papers, as shown in Fig. 6, was generally lower than that of the all-wood pulp control papers. However, the reduction did not seem to be large enough to affect greatly the normal use of these papers. The data in Tables I and II indicate that in all cases the folding endurance of straw-containing papers was considerably better than that of the control papers made from all-wood pulp furnishes. The densities of the straw-containing papers were, in general, somewhat higher than those of the wood papers. This is to be expected since the straw fibers of relatively short length and small diameter pack more readily. This is also evidenced by the greater air resistance and the better sizing of the papers containing straw pulp.

It must be emphasized at this point that these trial paper-machine runs were of the "single-shot" variety—there was sufficient straw pulp to make only one short run on each type of paper. It is, therefore, fairly improbable that the papers made had the optimum qualities that it is possible to produce from blends of straw with wood pulps. The results of these single trials are sufficiently encouraging, however, to warrant serious consideration of the use of straw pulp by the American paper industry and to justify further work and commercial trials of straw pulp—wood pulp blends.

SUMMARY AND CONCLUSIONS

Straw pulp prepared by the mechano-chemical atmospheric pulping process was bleached and blended with various wood pulps to produce a number of different types of papers.

These types included magazine-book for coating, newsprint, filled-book, bond, waxing, bag, and greaseproof papers.

Control runs were made using all-wood pulp furnishes.

The results show, in general, that formation, bursting and tensile strength, and folding endurance were improved by the inclusion of straw pulps in the various furnishes.

The tearing strength of the straw-containing papers was somewhat lower than that of the control, but the reduction in tear does not appear to be significantly great.

It is evident from these data that straw pulp can be used to good advantage in many types of specialty papers, and the results obtained in these preliminary runs show sufficient promise to warrant large commercial-scale trials.

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A New Method for the Addition of Neoprene Latex to Paper Pulp

J. R. GALLOWAY, R. H. WALSH, J. BURT, J. S. HICKMAN, and R. E. SHRADER

An investigation of some of the conditions found in normal papermaking operations as they affect the addition of and properties derived from neoprene latex was conducted. The procedure and results are discussed, and recommendations are given for a continuous addition procedure. The laboratory work was confirmed with mill trials which indicated a higher efficiency in regard to wet-strength improvement.

THE use of neoprene latex as a wet-end additive for papermaking was first described by Walsh, Abernathy, Pockman, Galloway, and Hartsfield (*3*) who showed that paper containing neoprene exhibited unusual wet-strength properties. The presence of neoprene also improved the flexibility of the paper and increased its elongation, folding endurance, internal bond strength, and chemical resistance. As a result of this work there has been considerable activity in the production of specialty paper containing neoprene, and already several products such as linoleum backing, filter papers, gasket papers, and twisting paper have attained commercial significance.

In the original paper the authors (*3*) reported an average wet strength of 35% obtained by the addition of 2% neoprene in 25 mill trials. However, they reported unexplained deviations from the norm. Wheeler, Borders, Swanson, and Sears (*4*) studied some of the factors which might explain these variations. They concluded that it was necessary to use alum rather than acids as the precipitant, that zinc oxide must be present to obtain good results, and that the final pH must be below 6.1. Unfortunately their work does not explain the variations obtained in the mill trials since all of the factory runs fulfilled these requirements.

In view of this background it was decided to investigate individually some of the conditions found in normal papermaking operations. In carrying out this work it was assumed that the two basic concepts developed by Walsh and his co-workers were valid. These concepts were that normal fiber-to-fiber bonding must not be affected greatly by the addition of the neoprene latex, and that the neoprene must be deposited as discrete particles. It is readily apparent that such factors as electrolyte content of the make-up water, agitation of the composite system, pulp plus latex, and the time the latex and the pulp are in contact prior to coprecipitation will have an important bearing on the fulfillment of these two concepts.

LABORATORY WORK

In the original work on the addition of neoprene latex to pulp it was stated that, in order to obtain satisfactory results, it was necessary to presensitize the latex by dilution and addition of a dispersing agent, followed by treatment with dilute alum to reduce the pH. This method of latex preparation required close chemical control and did not lend itself to routine mill operations. It was established by Graham (*2*) that the purpose of this presensitization was to coat each neoprene particle with a hull of an alumina-dispersing agent complex. Later work has established that, when the alum for final coagulation is added as a 5% solution, the hull is formed around the neoprene particle after it has been added to the pulp slurry. This method, which has simplified the procedure for addition of neoprene latex to paper pulp, has been followed in all of the work reported in this investigation.

The following laboratory procedures were used:

Pulp Preparation

Unless otherwise specified Ostrand 60 pulp was beaten to a Canadian freeness of 550 ml. at 3% consistency in a Noble & Wood cycle beater. Wet lap was formed at about 20% consistency by pulling the water out by suction on a 100-mesh screen. This beaten pulp was stored in a closed container.

pH Control

The pulp was adjusted to a pH of 8.5 with 5% sodium hydroxide solution.

Preparation of Zinc Oxide-Antioxidant Dispersion

A dispersed masterbatch of the zinc oxide and the antioxidant required in conjunction with the neoprene latex was prepared by wet grinding for 24 to 48 hr. in a pebble mill according to the following formula:

50% Zinc Oxide-Antioxidant Dispersion

	Parts by weight
Zinc oxide	100
Antioxidant	30
10% Dispersing agent solution	39
10% Ammonium caseinate solution	39
Water	52

Addition of Zinc Oxide-Antioxidant Dispersion

Sufficient quantity of this dispersed masterbatch was added to the pulp in the beater to incorporate 10 parts of zinc oxide and 3 parts of antioxidant per 100 parts of the neoprene being used in the experiment.

Preparation of the Latex

Neoprene Latex Type 735 was first treated with sufficient 5% alkaline, aqueous solution of a dispersing agent of the formaldehyde naphthalene sodium sulphonate condensation product class to introduce 8 parts per 100 parts of neoprene solids. Sufficient soft water was then added to dilute the mixture to 5% neoprene solids. No pH control of the diluted latex was necessary.

Addition of the Latex

The desired amount of prepared latex was added during one revolution of the pulp in the beater or in about 15 sec. The pulp-latex mixture was then allowed to circulate for 45 sec. before addition of alum solution. It was found that this procedure mixed the pulp and latex completely.

Addition of the Alum

One minute after the start of the addition of the latex, the sys-

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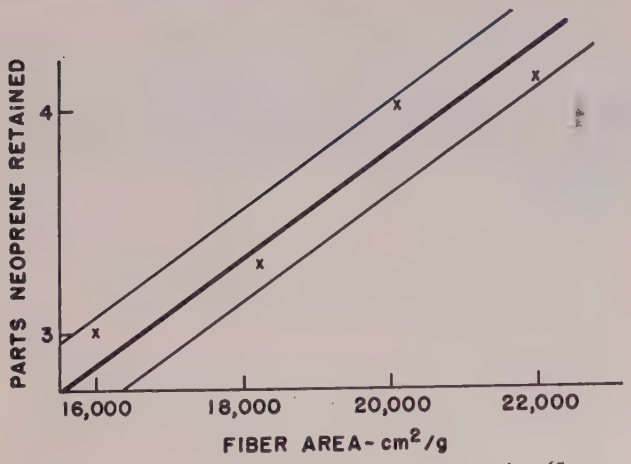

Fig. 1. Effect of fiber area on neoprene retention (5 parts added)

tem was coprecipitated by reducing the pH to 4.5 through the addition of 5% papermakers' alum solution. The major portion of the alum was added in one revolution of the pulp in the beater. The mixture was then dumped from the beater.

Preparation of Handsheets

Handsheets were formed, pressed, and dried using a Noble & Wood sheet machine. The stock was diluted to 0.1% consistency and the sheets were formed on a 60-mesh wire. They were pressed to 36% consistency, stripped from the wire, and dried between filter paper at a temperature of approximately 95°C. Sheet weights were controlled as closely as possible to 70 lb. (24 × 36—500).

Testing Method

All sheets were conditioned according to TAPPI Method T 402 m-49. Tensile test specimens, 1 by 7 in., were broken on on an L-5 Scott tensile tester in accordance with TAPPI Method T 404 m-47. Unless otherwise stated, wet-strength data were obtained on test pieces that had been immersed in water for 24 hr. at 23 ± 1°C. Wet strength is reported as a function of dry tensile strength and was calculated as follows:

$$\text{Wet strength} = \frac{\text{wet-tensile strength} \times 100}{\text{dry-tensile strength}}$$

Although Walsh and co-workers suggested that the presence of electrolytes such as sulphates in the make-up water could be responsible for poor wet strength, they presented no data to substantiate this premise. It was decided to determine the effect of sulphate ion because of its presence in tray water due to the use of alum as a coagulant. In conducting these experiments alpha pulp was used and the sulphate ion was introduced by the addition of sodium sulphate. Two concentrations were employed—a control containing no sulphate ion and one containing 0.025% sulphate ion. Table I shows data on the effect of sulphate ion on wet strength and neoprene retention obtained from handsheets made from pulp to which 5% neoprene had been added.

Table I. Effect of Sulphate Ion on Wet-Tensile Strength (5% Neoprene Added)

Sulphate ion concentration, %	$\frac{Wet}{Dry} \times 100$	*Neoprene retained*
0	33	3.25
0.025	23	3.93

At the level of sulphate ion selected, wet strength was impaired seriously in spite of the somewhat improved retention of neoprene. It is probable that precoagulation of the neoprene latex occurred in the water phase and that it was precipitated as large particles which were more easily retained by filtration, but which did not contribute efficiently to wet strength.

Although the concentration of sulphate ion used in this work was many times that normally found in an open system, it is not unusual for such a concentration to be reached in a conventional closed system. These data indicate that, when using neoprene, it is desirable to add recycled tray water on the machine side of the point at which the neoprene has been coagulated with alum.

Although there is no positive proof to explain the mechanism of retention of neoprene in a sheet of paper, it appears that both chemical bonding and mechanical entrapment are contributing factors. With both of these, fiber area would be expected to play an important role. In papermaking operations, fiber area normally is increased by beating or jordaning. In the former method, hydration and fibrillation are the most important causes of the increase; in the latter, cutting of the fiber is also a contributing factor. For laboratory experiments, beating is the most practical way of increasing fiber area and the silvering technique, as outlined by Clark, (*1*), is a satisfactory method of determining it. The effect of fiber area on the retention of neoprene is shown graphically in Fig. 1. These data show that the retention of neoprene is improved as the surface area is increased. However, since the curve covers only the very high freeness range and since the maximum possible retention value on this curve is 5, it is apparent that the factor of surface area is not so important in the normal operating range as would be expected by casual observation.

If one again considers the various methods by which a papermaker obtains increased surface area, it is apparent that they all involve refining operations which set up high shearing forces. It therefore is important to determine the effect of such violent agitation on the neoprene-pulp slurry because it is probable that one of the major factors determining the retention of neoprene is the entrapment of the particles within the normally formed fiber bundles as the alum is added.

This effect was evaluated in the laboratory by adding 5% neoprene to a sample of Ostrand 60, diluting to the test consistency, and dividing the sample in half. One half of the sample was agitated for 1 min. on an Eppenbach Homomixer before sheets were formed. Sheets

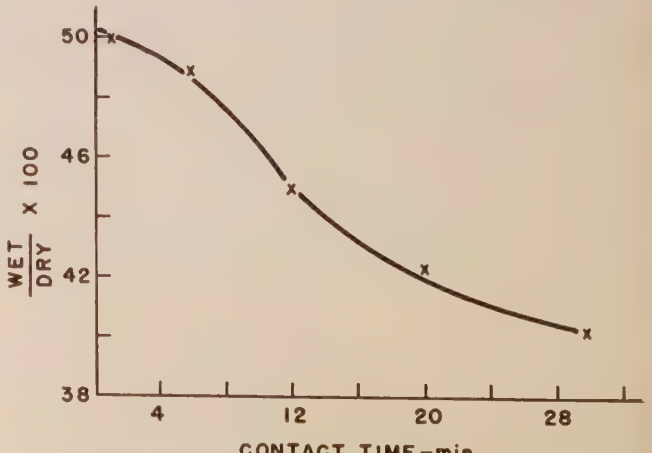

Fig. 2. Effect of contact time on wet-tensile strength (5% neoprene added)

were formed from the second half without prior agitation. Since the relationship between agitation and retention was the only factor being studied, the handsheets were pulled at the test consistency instead of following the standard procedure. The results are summarized in Table II.

Table II. Effect of Agitation on Neoprene Retention (5 Parts Added)

	Parts of neoprene retained at various consistencies		
	1.0%	*0.3%*	*0.1%*
No agitation	4.02	3.86	3.84
Violent agitation	3.87	3.16	1.90

In all cases agitation has resulted in a lowering of neoprene content. This loss is particularly apparent at the lowest consistency level studied. It is probable that the loss in neoprene represents material which has been separated from the fibers by the mixing action and resuspended in the water. This is more pronounced at low consistencies because the mean free path between the neoprene particles and the fibers is greater and the neoprene cannot again become entangled so readily in the fiber bundles. Had the stock, agitated at 1% consistency, been diluted immediately to the sheet-forming consistency according to standard practice, the loss of neoprene undoubtedly would have been greater.

One of the possible variables in the treatment of pulp with neoprene latex which has not been considered previously is the length of time that the latex is in contact with the pulp before the addition of alum. Reconsideration of the mill trials previously referred to discloses that, in normal operations, this contact time has varied from relatively short periods to as long as 30 min. This factor was evaluated in the laboratory by adding 5 parts of neoprene to 100 parts of Ostrand 60 at a Canadian freeness of 550 ml. and varying the time before the addition of alum. Figure 2 is a plot of the data from these experiments.

Inspection of this curve shows a striking decrease in wet strength as the contact time is increased. This decrease is pronounced particularly in the range of 6 to 20 min. The reason for the decrease is not apparent from the experiments performed, but it probably is associated with an interference with normal fiber-to-fiber bonding.

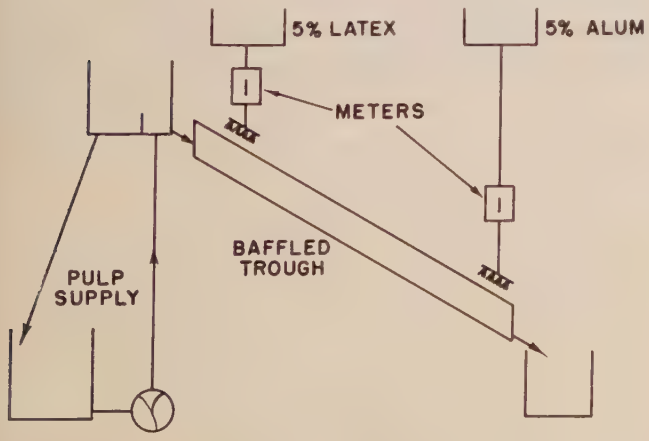

Fig. 3 Continuous addition apparatus

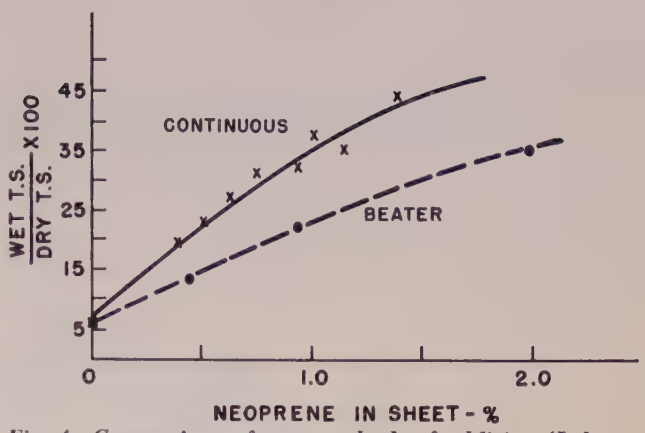

Fig. 4 Comparison of two methods of addition (Laboratory trials)

A review of the data which have been presented indicates that the method of addition of the neoprene must be modified if advantage is to be taken of the conditions which lead to optimum results. The effect of sulphate ion concentration indicates that neoprene must be added at some point prior to the addition of tray water. The effect of fiber area and agitation requires addition after the last refining has taken place. The startling effect of contact time indicates that the alum must be added as rapidly as possible after the latex and pulp are mixed. Furthermore, the mixing of the latex and pulp must be done rapidly, but, because of the pressure-sensitive nature of neoprene latex, agitation must not be violent. Such conditions can be fulfilled most readily by a continous process in which mixing is obtained by a folding action such as that which results when flowing the mixture down an inclined baffled trough.

For laboratory experiments an apparatus as shown in Fig. 3 was constructed. In this apparatus the pulp was pumped from a source of supply to a constant head metering box from whence it flowed through an adjustable gate to the baffled trough. The trough was 3 in. wide, 6 in. deep, and 15 ft. long. Both sides of the trough were equipped with adjustable baffles on 12-in. centers. The baffles were 1 in. wide at the top and 2 in wide at the bottom so that pulp flowing past them would be mixed by a folding action. The speed of flow of the pulp was adjusted by changing the slope of the trough, and the degree of agitation was changed by adjusting the angle of the baffles. The angle of the trough for these experiments was set so that the pulp flowed freely and the baffles were adjusted so that mixing occurred rapidly but without violence. The latex and alum were metered separately by rotometers from constant head supply drums to any selected point along the trough and the treated pulp was collected at the end of the trough.

A series of experiments was conducted which were designed to compare the efficiency of this new continous procedure with that of the standard beater process. The pulp was used at a consistency of 1%. The 1-min. contact time selected for the beater experiments is about as short as practical with this method of agitation. The contact time for the continuous procedure was less than 1 sec. and was about the minimum for adequate mixing.

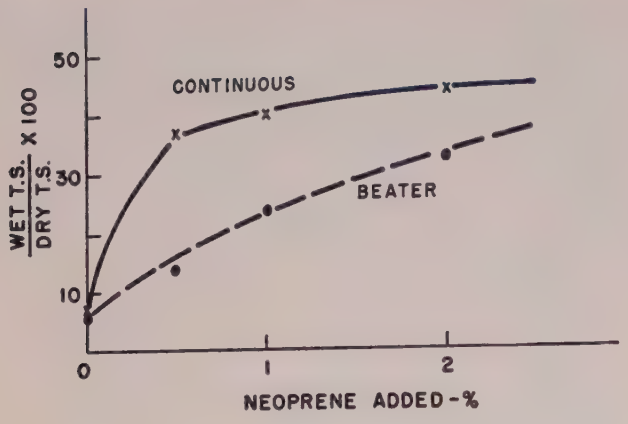

Fig. 5. Comparison of two methods of addition (Mill trials)

From Fig. 4, which is a plot of data from these experiments, it is evident that the results from the continuous method show a marked improvement in efficiency over the results obtained from the beater addition method. The improvement is most striking when one compares the amount of neoprene required by the two processes to obtain a given amount of wet strength. It should be pointed out that the 1-min. contact time used for the beater addition experiments is in the most efficient region for this type of addition. (See Fig. 2.)

MILL TRIALS

In view of the excellent results obtained in the laboratory with the new continuous method of addition, arrangements were made to carry out a series of experiments on a mill scale using a bleached kraft furnish. As far as mill operating procedures would permit, these experiments were performed under the optimum conditions described in this paper. The baffled trough was located at the jordan outlet so that the neoprene latex could be added to the pulp after the maximum fiber area had been obtained. Addition at this point also minimized the amount of agitation in the pulp-latex-alum system. The make-up water for the pulp was free of sulphate ion and there were no recycling lines which bypassed the trough back into the system. The zinc oxide and antioxidant dispersion necessary for good aging of the neoprene was added at the beater and the pH at the head of the trough was controlled at 8.5 by adding sodium hydroxide at the beater. The latex and alum were added through flowmeters from constant head supply drums. The rate of flow of the latex was adjusted so that 0, 0.5, 1, and 2% neoprene, based on the weight of pulp, were added. The alum flow was adjusted to give a pH of 4.5 at the trough outlet. The treated pulp was diluted with tray water and passed directly to the headbox of the fourdrinier machine which produced a sheet of 60 lb. basis weight (24 × 36—500). A set of control experiments also was performed in which the neoprene was added at the beater by the standard technique using the same furnish and the same percentages of neoprene.

Figure 5 is a plot of the test data obtained. The marked improvement of the continuous method over the beater method is confirmed fully by these mill scale tests; in fact, the results at all neoprene concentrations below 1% are much better in the mill trials than they were in the laboratory experiments. The tests indicate that, using this technique, the addition of 0.5% neoprene will produce as much wet strength as the addition of 2% by the older method. It is noteworthy that the results of the beater trials shown in Fig. 5 are consistent with previously published results for this method of addition.

The excellent results obtained in the first mill scale trials of the continuous method of addition prompted other such trials using a variety of furnishes. The results of these tests which were all made using 0.5% neoprene are summarized in Table III.

Table III. Mill Trial Results (0.5% Neoprene Added)

Type of paper	*Basis weight (24 × 36—500), lb.*	*Wet-tensile strength / Dry-tensile strength × 100*
V2S board	240	25
Bleached kraft tag	60	33
Kraft filter	60	22
Sulphite glassine	25	23
Kraft twisting		
Domestic semibleached	30	20
Canadian	15	26
Finnish	15	33

It will be noticed that all of these results are higher than would be expected at this neoprene concentration if the neoprene were added by the beater addition method. The lowest of these results is equivalent to that obtained in the laboratory experiment (see Fig. 4) while the highest is equal to those in the first mill scale trial (see Fig. 5). Part of this variation can be explained by the fact that, in some of these trials, the furnish or the operating conditions were such that the optimum conditions described could not be satisfied completely.

SUMMARY

A new continuous method of addition of neoprene latex has been developed from a study of the conditions which may have caused variations in the results obtained using the beater addition technique. This procedure consists of mixing the pulp, the latex, and the alum solution in quick succession in a continuous manner at some place in the pulp system on the machine side of the jordan before dilution with tray water. Such a continuous method satisfies the conditions for minimum electrolyte content, maximum fiber area, short contact time, and minimum agitation of the pulp after precipitation of the latex.

A series of mill scale trials has been described which indicates that, in all cases, the amount of wet strength obtained by this method is greater than that realized by the beater addition method. In many cases, 0.5% of neoprene added continuously is as efficient as 2% added at the beater.

LITERATURE CITED

1. Clark, J. d'A., *Paper Trade J.* 115, No. 1: 32–39 (July 2, 1942).
2. Graham, D. P., unpublished results.
3. Walsh, R. H., Abernathy, H. H., Pockman, W. W., Galloway, J. R., and Hartsfield, E. P., *Tappi* 33, No. 5: 232–237 (May, 1950).
4. Wheeler, G. W., Borders, A. M., Swanson, J. W., and Sears, G. R., *Tappi* 34, No. 7: 297–301 (July, 1951).

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Acid Pulping—Strainer and Circulation Survey

JOHN M. McEWEN

The TAPPI Acid Pulping Committee sent a questionnaire on strainers and forced circulation to 61 mills. Such a survey has certain shortcomings, but there seemed to be rather general agreement on some points. Mills having forced circulation believed it gave them better quality and a more uniform pulp. The mills reporting the best circulation had normal or low free SO_2 in their acid, split circulation, and hydroheaters or indirect heaters. There was some question as to the effect of the location of the strainers, area of strainers, and whether removing side relief to within a foot or so of the strainers would cause poorer circulation. The ability to circulate was seemingly not affected by the amount of chip packing, normal strainer cleaning variations, final permanganate number, maximum temperature, or length of cooking cycle.

THE Acid Pulping Committee sent a questionnaire on strainers and forced circulation to 61 mills. Fifteen mills replied that they did not have forced circulation. The 24 forced circulation replies are tabulated in the Appendix. Dashes mean the question was not answered or was answered in such a way that it could not be used in the table. In some cases a mill's reply was simplified for the table by using the average if a small range was given. When more than one type of equipment was given, only the main equipment is listed in the table.

A Nov., 1949 survey reported by J. M. Wilcox (*1*) indicated that 35% of the sulphite tonnage was made with no circulation, 23% with circulation only, 29% with circulation and heaters, and 13% with circulation and hydroheaters. A much higher percentage of mills selling pulp had circulation systems than did the mills converting all their production. Mills producing higher grades of pulp reported more circulating systems. This report also indicated that about 65% of the mills used chip packing.

TYPE OF CIRCULATION

Ten mills reported split circulation systems and 12 reported top to bottom circulation. Each mill was asked to report its maximum circulation, the circulation rate when the steam is just in, and the circulation rate just before the blowdown. Many of the mills did not known their circulation rates and could not be included in the tabulation. Results are shown in Table I.

Table I. Comparison of Different Types of Circulation

	Split circulation	*Top to bottom circulation*
Mills reporting type of circulation	10	12
Mills reporting rate of circulation	8	10
Circulation when steam is just in		
Less than 50% of maximum	1	3
More than 50% of maximum	7	7
Circulation just before blowdown		
Less than 50% of maximum	3	10
More than 50% of maximum	5	0

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Table II. Type of Digester Heating

	Indirect heaters	*Hydro-heaters*	*Direct steam*
Total mills	11	5	8
Mills reporting circulation	9	3	6
Maximum circulation mills	3	2	0
Minimum circulation mills	1	0	3
Mills with no circulation decrease during steaming	8	3	3
Mills with circulation decrease during steaming	1	0	3

The mills with split circulation reported better circulation than did those with top to bottom circulation. There were only five mills having more than 50% of maximum circulation at the blowdown. These all had split circulation systems. Of the four mills having the poorest reported circulation only one had split circulation.

Since five mills reported above average results and four mills reported below average results, we will investigate the other characteristics reported, with special emphasis on the maximum circulation mills and minimum circulation mills.

TYPE OF HEATING

Table II gives the breakdown of mills by the type of heating used. It shows most of the mills with poorest circulation to use direct steaming while none of the best circulation mills use it. It also indicates that none of the mills using hydroheaters reported any reduction in circulation during the steaming period.

CHIP PACKING

Mills were requested to report the air-dry pounds of chips per cubic foot of digester space. Maximum packing seems to be from 10 to 12 air-dry lb. per cu. ft. Two mills reported values of about 20 lb. per cu. ft., but it is suspected that these are on a wet or "as is" basis rather than air-dry (90% oven dry). Two other mills reported values of about 5 lb. per cu. ft.—it is probable that these mills reported pounds of air-dry pulp per cubic foot. These results are summarized in Table III.

Unfortunately only one of the maximum circulation mills reported the amount of chip packing. This mill reported 10.3 air-dry lb. per cu. ft. The minimum circulation was evenly divided above and below 10 lb. per cu. ft. There were only ten mills reporting com-

Table III. Effect of Chip Packing

	Under 10 air-dry lb./cu. ft.	*Over 10 air-dry lb./cu. ft.*
Circulation when steam is just in		
Less than 50% of maximum	2	2
More than 50% of maximum	2	4
Circulation just before blowdown		
Less than 50% of maximum	4	5
More than 50% of maximum	0	1

Table IV. Effect of Side Relief

	Height above strainers, ft.
Maximum circulation mills	4, 23, No.[a], No.[a]
Minimum circulation mills	4, 5, 6, 11 1/2

[a] Mill does not remove side relief.

plete data on both chip packing and circulation. Results do not show chip packing to influence circulation. Certainly there is no reason to believe that packing under 10 air-dry lb. per cu. ft. will help circulation.

SIDE RELIEF

Some mills have reported that at times circulation has stopped very early in the cook. Investigation had showed that too much side relief had been taken and the liquor level was very close to the strainers. Of course if all the liquor is removed down to the strainers in recovering the side relief there will be none left to circulate. To prevent this some mills have installed special side relief ports rather than removing the side relief through the strainers.

Mills were asked to report the height above the strainers to which they lowered the liquor when taking off the side relief. Results for the extreme mills are reported in Table IV.

Examination of the full data shows that all of the four mills having 3 ft. or less of liquor over the strainers get good circulation through the steaming period. Thus the lack of circulation in the minimum circulation mills does not seem to be due to taking off too much side relief. However, it may be noted that three of the four maximum circulation mills either took no side relief or had strainers located in the bottom of the digester. Some mills have reported a drop-off in circulation when the side relief is taken off but that may be due to the stage of pulping.

CLEANING OF STRAINERS

If strainers become completely limed over they will obviously stop circulation. Each mill reported how often they cleaned their strainers. Some mills washed their strainers after each cook and others removed their strainers every 6 mo. to a year for a complete clean-up including sand blasting.

There seemed to be no set pattern between the mills' cleaning program and circulation. The maximum circulation mills cleaned their strainers every 1 to 9 mo. and the minimum circulation mills every 4 to 8 mo. It seems reasonable to assume that each mill cleans its strainers often enough to maintain its circulation and the time interval depends on the individual mill conditions.

STRENGTH OF ACID

Mills reporting poor circulation have noted that as pulping is speeded up by using stronger acid or a faster temperature rise, the circulation falls off sooner. This is to be expected if the drop in circulation is due to pulp plugging the strainers. However, it may be that abnormal amounts of free SO_2 in the digester may help disintegrate the chips faster by violent gassing off. Table V shows the amount of free SO_2 used by the extreme mills.

Table V. Effect of Free SO_2

	Per cent free SO_2
Maximum circulation mills	4.5, 4.5, 4.95, 5.3, 6.25
Minimum circulation mills	5.5, 6.5, 7.5, 10.0

As a rule the mills having higher free SO_2 had more circulation trouble than those maintaining a lower free. All mills did not know or report circulation rates, but half those having over 6% free reported a circulation drop-off during steaming while only two out of nine mills having less than 6% free reported a drop-off. Only two mills reported over 7% free SO_2 and they both experienced a very great drop-off in circulation during the steaming period. Thus it appears that high free SO_2 in the acid inhibits circulation.

Table VI. Effect of Degree of Cooking

	TAPPI permanganate number
Maximum circulation mills	10, 10, 10.5, 11, 12.5
Minimum circulation mills	11, 11.4, 12.5, 14.5

DEGREE OF COOKING

Since the rate of circulation decrease seems to depend upon the rate of pulping, it was thought that perhaps the mills cooking to a low permanganate number might have more difficulty than those making harder pulps. Degree of cooking was reported in various terms, but all were converted to TAPPI permanganate numbers for ease in tabulation. Results are given in Table VI.

Table VI indicates the mills with good circulation cooked to a slightly greater degree than those with poor circulation. Permanganate numbers between 7 and 16 were reported. Most were 10 to 12. Two mills reporting 16 permanganate numbers had about the same circulation as two mills reporting permanganate numbers under 9. Thus mills cooking soft pulp did not experience any unusual circulation difficulties.

MAXIMUM TEMPERATURE

A higher maximum temperature might speed the pulping process and reduce circulation faster. The maximum temperatures for the extreme mills are reported in Table VII.

Maximum temperatures of from 135 to 155°C. were reported. Within the limits reported, the maximum temperature does not seem to affect circulation efficiency.

COOKING CYCLE

The rate of pulping depends on the cooking cycle. Perhaps fast or slow cooking cycles might affect circulation. Mills were asked to report the number of hours till they started to relieve the digesters for the blowdown. Results for the extreme mills are given in Table VIII.

Times reported for the blowdown ranged from 4 1/2 to 9 hr. As noted in Table VIII for the extreme circulation mills, there seems to be no correlation between the cooking cycle as measured by the time of blowdown

Table VII. Effect of Maximum Temperature

	Maximum temperature, °C.
Maximum circulation mills	140, 143, 144, 147, 150
Minimum circulation mills	139, 140, 145, 150

Table VIII. Effect of Time of Blowdown

	Time of blowdown, hr.
Maximum circulation mills	4½, 5, 6, 6½, 9
Minimum circulation mills	5¼, 5¾, 6¾

and the continuation of circulation. No doubt fast steaming causes faster pulping and strainer plugging—but it also speeds up the cook so the cook is also completed sooner.

STRAINER AREA

Some mills feel that they get better circulation when the strainer area is small and there is a high velocity through the strainers. Parts of strainers have been blanked off to obtain this greater circulation rate. Three of the five maximum circulation mills reported part of the strainer area blanked off. Two other mills reported parts of the strainers blanked off. None of the minimum circulation mills reported any portion of the strainers blanked off.

Table IX gives a comparison of the square feet of strainer area with circulation rate. It may be noted that three of the four mills reporting poor circulation reported very high circulation per square foot of strainer area. Most mills reported about ¼-in. strainer holes on about ½-in. centers. There appeared to be no difference between the hole size and spacing of maximum and minimum circulation mills.

It is very difficult to draw conclusions as to the effect of strainers. On one hand mills blanking off part of their strainers have better circulation, and on the other, those having the least proportionate strainer area have the worst circulation. There may be some significance to the fact that in Table IX the mills having the biggest pumps have the poorest circulation. It is conceivable that a great volume of liquor rushing through the strainer may not only keep it free from scaling, but also break up the chips near the strainer and plug it with pulp.

STRAINER LOCATION

Mills reported from 88 to 15% of the digester volume to be above the strainer. Although several mills commented that lowered strainers gave better circulation, the survey does not show any correlation between the circulation rates and strainer location. This is illustrated by the values for the extreme circulation mills in Table X.

OTHER ITEMS

Other items of interest in the questionnaire which might have been of importance had the survey showed

Table IX. Comparison of Strainer Area and Circulation Rate

Maximum circulation mills			*Minimum circulation mills*		
Strainer area, sq. ft.	*Maximum circulation g.p.m.*	*Ratio, g.p.m./ sq. ft.*	*Strainer area, sq. ft.*	*Maximum circulation, g.p.m.*	*Ratio g.p.m./ sq. ft.*
68½ × 70%	1000	21	118	3500	30
111	2250	20	27½	3400	125
80	2250	28	22½	2500	110
51 × 89%	1740	38	10.9	3000	275

Table X. Volume of Digester Above the Strainer

	Volume in %
Maximum circulation mills	15, 30, 33, 50, 88
Minimum circulation mills	24, 28, 30, 45

chip packing to be highly significant were the blow pressure and blow aids. These are tabulated in the Appendix. Fifteen of the 24 mills used steam as a blow aid and one used white water. Two of the mills using steam also used waste liquor for dilution during the blow. Blow pressure varied from 13 to 50 p.s.i. Twenty-one pounds blow pressure was the lowest reported for a mill with no blow aid and that mill had little chip packing.

COMMENTS BY MILLS

Mill 1 reported that if circulation has to be stopped they get high screenings and inferior pulp.

Mill 3 reported much improved circulation in an experimental digester with a hydroheater, low strainer, and split circulation—compared to their normal direct steaming and top to bottom circulation. They also indicate that circulation can be prolonged by using weaker acid or slower steaming—but the cook is also prolonged so nothing is gained.

Mill 4 reported no improvement in pulping and only slight circulation improvement when one of their top to bottom digesters was altered by lowering the strainer to 50% of the volume and giving split circulation. The lowered strainer gave them less scale on the strainer but more on the circulating lines.

Mill 4 has found there to be no advantage to having a large strainer area around the digester. They have removed half of their strainers (which used to go around the entire digester circumference). They found no loss in uniformity or quality. They have not detected any ill effects even when their half ring strainers were all scaled over except in the immediate area of the outlet. They feel that:

1. The provision of a large strainer area to distribute the flow all around the digester is not as important as previously believed and has no significant effect on cooking.

2. The important advantage of forced circulation to obtain a uniform cooking treatment are achieved in the early stages of the cook before the pulping is sufficiently advanced to produce fibers which will clog the strainers. This would probably apply to the part of the cook below 130°C.

3. Strainer location (below the liquid surface) does not determine the circulating time to a significant degree. The controlling factor is the time when the wood starts to defiber and produce plugging of the strainers.

Mill 6 reports that the addition of circulation has given them a satisfactory pulp with shorter cooking cycle.

Mill 8 reports improved circulation with the installation of indirect heat exchangers.

Mill 11 reports their chief circulation difficulty is with liming on strainers and heater tubes. They eliminated burned chips by first putting an orifice in the circulating line and later installing a recirculating line. The orifice was removed when the recirculating line was installed.

Mill 13 improved their circulation when they cut their blowdown cam in steps rather than for a gradual decrease in pressure.

Mill 14 feels the strainer should be located in the center of the digester so it will be low enough for full cook circulation with maximum side relief and also be high enough to balance hydraulic forces.

Mill 15 reports that circulation has definitely aided in producing a better quality pulp with fewer rejects.

Mill 19 feels that there is an advantage to have circulation to both top and bottom.

Mill 22 reported an increase in physical tests when they went to forced circulation. For example, bursting strength was about 10% higher on all grades.

Mill 23 reports that the addition of a circulation system has permitted them to cook to a predetermined schedule, shortened their cooks (increased output), improved pulp strength and uniformity, reduced screenings, and stopped burned cooks.

Mill 24 has installed a bottom strainer on one digester. They have indications of more uniform brightness, strength, and screenings. They have packed some digesters heavily and had an increase in dirty blows but packing did not decrease circulation.

One of the mills having natural circulation plans to install a circulation system with the strainer just above the bottom cone. They feel this with split circulation will give the greatest efficiency.

SUMMARY

Most mills having forced circulation are convinced that it gives them better pulp uniformity and quality. Some mills report better circulation than others. Answers to a questionnaire cannot equal a carefully controlled experiment since all factors cannot be covered, in some categories there are too few replies, and some mills may misinterpret a question and thus give a false answer. Recognizing these shortcomings, the survey showed mills with the following equipment to report the best circulation:

1. Split circulation better than top to bottom.
2. Hydroheaters or indirect heaters better than direct heaters
3. Medium free SO_2 better than that over 7%.

There was disagreement in the data or opinions expressed on the following points:

1. Location of strainers—most preferred strainers at 50% of volume or lower but data did not show low strainer mills to be consistently better and one mill reported a study showing no great difference.
2. Strainer area—some mills report better results when small strainer area is used to increase velocity through strainers, yet high velocity mills reported some of the worst circulation.
3. Removal of side relief—most of the best circulating mills did not remove side relief close to strainers, yet mills reporting very close removal of side did not show poor circulation.

The following items did not correlate with the reported ability to circulate: (1) amount of chip packing, (2) normal variations in cleaning strainers, (3) degree of cooking (final permanganate number), (4) maximum temperature, and (5) length of cooking cycle.

LITERATURE CITED

1. Wilcox, J. M., *Tappi* 33, No. 6: 272 (June, 1950).

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Appendix—Summary of Replies to Questionnaire

Mill No.	Type heater	Air-dry chips/ cu.ft.	Blow press-sure, p.s.i.	Blow aid	Waste liquor dilu-tion	$KMnO_4$ No.	Max. temp., °C.	Per cent free	Per cent com-bined	Liquor over strainer, min. ft.	Strainer area sq.ft.	Area blanked off, %	Clean strainers every	Volume above strainer %	Hours to blow-down	Hours circulation continued	Liquor to top, %	Liquor to bottom, %	Maximum circulation, g.p.m.	Circulation at end of steaming, g.p.m.	Circulation just before blowdown, g.p.m.
1	Hydroheater	10.3	13	Water	No	10.0	140	6.25	1.18	4	68.5	30	3 mo.	30	6	Throughout	20	78	1000	1000	700
2	Indirect	—	45	No	No	10.5	147	4.50	1.00	No side	111	No	6 mo.	50	4½	Throughout	50	50	2250	2250	2250
3	Direct	10.7	28	No	No	12.5	140	10.00	1.20	4	118	No	6 mo.	30	5¼	4¾	0	100	3500	200	50
4	Indirect	9.3	25	Steam	No	11.4	139	7.50	1.00	5	27.5	—	8 mo.	24	5¾	5¼	0	100	3400	0	0
5	Hydroheater	12.0	30	Steam	No	13.5	142	5.85	1.45	2½	60	8½	mo.	30	5½	—	0	100	1600	1600	0
6	Indirect	9.5	40	Steam	No	11.0	145	5.50	1.05	No side	75	No	6	20	6½	—	20	80	2200	?	?
7	Indirect	5.3	30	Steam	Yes	11.0	142	3.80	1.20	No side	36	No	mo.	33	9	8¾	0	100	2500	?	?
8	Indirect	10.5	35	Steam	No	12.0	143	—	—	1½	122	No	Cook	28	5½	4¼	0	100	3250	3250	0
9	Direct	17.0	25	Steam	No	16.0	135	5.50	1.18	7	33	No	3½ mo.	33	7½	—	0	100	1800	1800	?
10	Direct	10.2	30	Steam	No	14.5	150	5.50	1.00	6	22.6	No	4 mo.	28	—	—	0	100	2500	824	0
11	Indirect	—	35	No	No	12.5	144	4.50	1.05	—	80	No	9 mo.	15	9	9	4	96	2250	2250	2250
12	Indirect	7.1	28	Steam	No	6.5	146	5.50	.83	10	36	No	1 mo.	20	5	5	33	67	2000	2000	0
13	Hydroheater	10.8	50	Steam	Yes	12.5	137	5.60	1.15	7½	40	No	6 mo.	40	6¼	—	—	—	—	—	?
14	Direct	9.0	20	Steam	No	15.0	140	5.95	1.05	12	—	10	1 mo.	45	7¾	7¾	45	55	2500	?	?
15	Direct	9.5	45	Steam	No	11.0	145	6.50	1.00	11½	10.9	No	6 mo.	45	6¾	5½	25	75	3000	750	300
16	Direct	21.0	50	Steam	No	8.5	155	4.00	1.00	10	—	No	Cook	67	8½	—	—	—	—	Good	Good
17	Indirect	—	24	No	No	12.0	137	6.70	1.15	No side	—	No	—	84	6	5¼	71	29	1750	1750	0
18	Indirect	—	35	No	No	—	140	—	—	No side	100	No	12 mo.	16	5	4¼	0	100	3600	3600	0
19	Direct	21.5	28	Steam	No	10.3	141	5.56	1.14	3	13.8	No	Wk.	20	6½	6¼	0	100	1500	1350	500
20	Indirect	—	40	Steam	No	10.0	150	4.95	1.05	No side	—	33	3 mo.	33	5	Throughout	33	67	100%	100%	100%
21	Direct	10.2	30	Steam	No	12.0	138	8.50	1.20	5	51.8	20	6 mo.	25	5¼	Throughout	0	100	3500	3500	1500
22	Hydroheater	—	33	No	No	11.0	143	5.30	1.20	23½	51	11	1 mo.	88	6½	6½	82	18	2680	2680	1740
23	Hydroheater	9.5	33	No	No	14.0	140	5.00	1.00	4	—	No	6 mo.	30	6½	6½	0	100	2500	?	?
24	Indirect	4.9	21	No	No	16.0	138	5.70	1.22	1	86	—	12 mo.	20	6	5¼	0	100	3500	3500	0

Some Observations on Sulphate Turpentine Recovery

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Recovery of crude sulphate turpentine is becoming of more economic importance as a stable market has developed for this material. Southern pulp mills recover up to 4 gal. per ton and northern mills recover somewhat less. Some of the important factors in the design of recovery units are discussed. The design of an automatic decanting tank for separation of crude sulphate turpentine and steam condensate is given which minimizes trouble with emulsion formation. Corrosion of steel by crude sulphate turpentine is caused by the sulphur compounds which are present, and it is quite severe, particularly in the vapor phase and at a pH below 8. A simple method of preventing this corrosion has been found which consists of adding 0.25% of 28% aqueous ammonium hydroxide to the crude sulphate turpentine. This method has been used to prevent corrosion in tank cars and storage tanks.

With the increase in value of sulphate turpentine in recent years the efficient recovery of sulphate turpentine is of greater economic importance than in the past. Crude sulphate turpentine is now selling at 25 to 35 cents per gal. delivered and yields of up to 4 gal. per ton of pulp are reported when slash or longleaf pine are processed. Yields from other species are somewhat lower. However, nearly all species of pine will yield at least 1.5 gal. per ton even in the northernmost mills.

An efficient sulphate turpentine recovery unit should not only recover a high percentage of the available turpentine but should operate with a minimum of attention from operating personnel.

SEPARATORY SYSTEM

A flow sheet of a sulphate turpentine recovery unit is shown in Fig. 1. This consists of a separatory system to remove entrained black liquor and pulp, a condenser to condense all vapors, a continuous decanter to separate the turpentine from the underflow water, and storage tanks to hold the finished product.

Many different types of separatory systems are employed, however, one of the most successful includes a small tangential separator on each digester. The vapors from the small separators enter a single larger separator which relies more on holdup of the vapor than on tangential action. All of these separators should be well insulated. The separated liquid may be sent either to the blow tank or the black liquor tank. The vapors, of course, pass on to the condensers. Adequate separation is essential to prevent emulsion formation.

The condenser may be designed assuming that all of the condensate is water, since the latent heat of steam is much more than the latent heat of turpentine. However, it is essential that all visible vapor be condensed since the turpentine tends to concentrate in the non-condensed vapor. Newer installations tend to favor a condenser with vapors inside the tubes in order to facilitate cleaning. These may be either single or multiple-pass type. However, multiple-pass condensers are usually preferred because of the lower exit temperatures.

The transfer of condensate to the decanter should be carried out with a minimum of turbulence to prevent emulsion formation. A straight gravity flow is preferred.

After the turpentine overflows from the decanter it may be pumped to the storage tanks. Corrosion is more of a problem in the storage tanks than in other parts of the system because the turpentine becomes more corrosive with age. Since the rate of vapor phase corrosion is approximately ten times that of liquid phase corrosion, the effects may be minimized by always operating with a full tank. One method of doing this is to operate with a pad of water under the turpentine. This water is discharged from the storage tank through a hydrostatic leg which is elevated above the top of the tank. On loading tank cars, the hydrostatic leg is closed off and water is pumped into the tank displacing the turpentine.

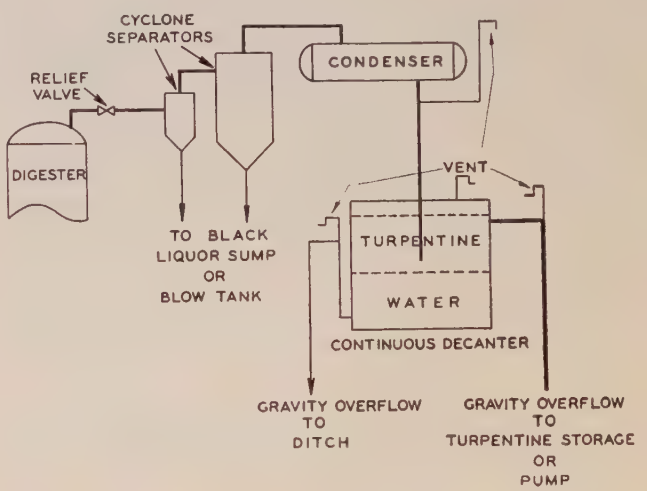

Fig. 1. Flow sheet-sulphate turpentine recovery system

Numerous mills have been visited to give assistance on the recovery of sulphate turpentine. In a majority of the cases where trouble was being encountered, the difficulties were centered around the decanter. A few more comments on design and operation of this equipment seem in order.

Decanter

The function of the decanter, of course, is to separate the condensed turpentine from the condensed steam (underflow water). This separation is best accomplished using a tank designed with a hydrostatic leg which controls the flow of both the turpentine and the underflow water so that no throttling valves are

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needed. This procedure has not been adequately described in the literature.

The amount of turpentine in the total condensate will vary depending on the operation but usually will be between 2 and 25% of the total. In some cases an emulsion is formed. This is generally the water-in-oil type which is lighter than water and floats on top of the water in the lower portion of the turpentine layer. In some cases where excessive turbulence is present in the condensers or between the condensers and the decanter, sufficient noncondensables are entrained to make the emulsion lighter than the turpentine, causing it to float on the turpentine.

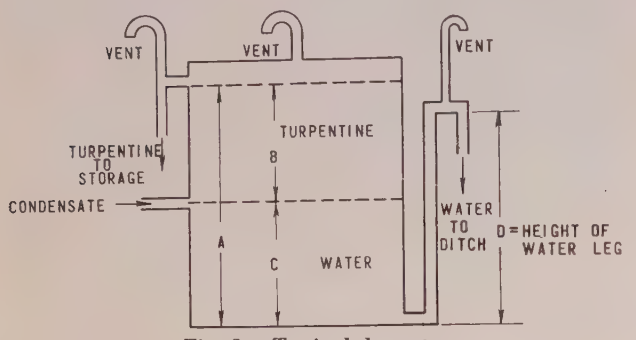

Fig. 2. Typical decanter

Since this emulsion is usually present in the turpentine layer, it is advisable to allow more holdup time in the decanter for the turpentine than for the underflow water, thereby allowing sufficient time for the emulsion to break without being carried to the storage tanks. This can be accomplished in most cases by allowing equal volumes of turpentine and water to be retained in a decanter of sufficient size. The minimum total volume of the decanter appears to be approximately 10 gal. per ton of pulp production.

In Fig. 2 a drawing of an improved decanter is given. A formula for its operation can be derived as follows:

Let

A = height of total liquid layer or the distance from the bottom of the decanter to the turpentine overflow
B = height of the turpentine layer within the decanter
C = height of the water layer within the decanter
D = height of the water leg
d_t = density of the turpentine at the operating temperature of the decanter
d_w = density of the water at the operating temperature of the decanter

Then

$$A = B + C$$

For recommended conditions

$$B = 0.5A$$

$$C = 0.5A$$

Pressure at bottom of decanter $= Bd_t + Cd_w = 0.5Ad_t + 0.5Ad_w = 0.5A(d_t + d_w)$

Pressure at bottom of leg $= Dd_w$

Then since these pressures must be equal

$$0.5A(d_t + d_w) = Dd_w$$

$$D = \frac{0.5A(d_t + d_w)}{d_w} \qquad (1)$$

It should be pointed out that this formula is applicable only if the water leg is sufficiently large so that negligible back pressure is caused by fluid flow, since any back pressure increases the depth of the water layer. In addition, the piping should be arranged so that the turpentine and also the water are carried away either by gravity flow or by pumps as fast as they overflow so that no back pressure is built up. The leg and overflows should be piped externally so that the effects of corrosion can be immediately noted and repairs may be easily carried out.

In order to prevent excessive evaporation loss, it is recommended that the decanter be operated at 120°F. since at higher temperature the vapor pressure of the components of turpentine increases rapidly. If the decanter must be operated at higher temperatures, a condenser should be placed on the vents with the condensate returning to the decanter.

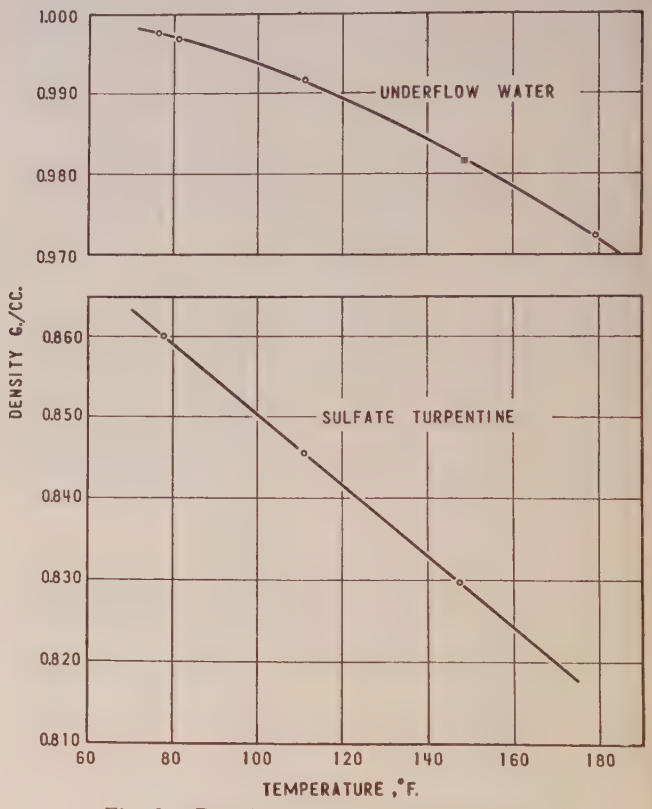

Fig. 3. Density at various temperatures

Figure 3 shows the density of turpentine and water at various temperatures as determined on samples from one particular installation. From the values at 120°F., $d_t = 0.8413$ gram per cc. and $d_w = 0.9895$ gram per cc.

Then equation 1 becomes:

$$D = \frac{0.5A(0.8413 + 0.9895)}{0.9895} = 0.925A \qquad (2)$$

If under the above conditions a floating emulsion is encountered due to entrained air, it may be necessary to place a baffle across the turpentine overflow to prevent the floating emulsion from going to the storage tank.

As pointed out earlier, crude sulphate turpentine is

quite corrosive to mild steel, particularly in the vapor phase. Corrosion tends to become worse as the age of the sulphate turpentine increases. This effect has been noted before by Norton, Lowe, and Calhoun (*1*) who attribute it to a gradual settling out of entrained black liquor from the turpentine. This results in a lowering of the pH of the sulphate turpentine allowing the naturally acidic sulphur compounds to exhibit their maximum corrosive action. Probably oxidation of sulphur compounds to volatile acids causes vapor phase corrosion. A number of crude sulphate turpentine samples and fractions of these samples have been examined in the laboratory and it was found that the corrosion was more pronounced in the samples which have a high sulphur content. The principal sulphur compounds are methyl mercaptan in the underflow water layer and dimethyl sulphide and dimethyl disulphide in the turpentine layer. As the samples become more acidic their corrosiveness increases. The

Table I. Corrosion of Mild Steel by Crude Sulphate Turpentine

Sample	*pH before test*	*Corrosion rate, in. per yr.* *Vapor*	*Liquid*	*pH after test*
Underflow water from mill A	9.6	0.8260	0.0005	9.8
Crude turpentine from mill A (1 day old)	8.9	0.0327	0.0221	8.3
Crude turpentine from mill B (7 days old)	8.0	0.3136	0.0596	4.9
Crude turpentine from Hercules storage tank (30 days old)	8.1	0.0685	0.0256	4.3
Crude dimethyl sulphide	6.0	0.0655	0.2200	4.6
Pure dimethyl sulphide	7.2	0.0805	0.1050	7.8
Crude dimethyl disulphide	2.6	0.3010	0.6050	4.5

results of these tests are given in Table I. The pH was determined on an equal volume of distilled water extract of the turpentine. The pH changed between the limits given during the tests which were of 4 to 7 days' duration.

CORROSION CONTROL

Corrosion in tank cars and storage tanks by crude sulphate turpentine in the vapor phase has been a serious problem. A simple treatment to prevent this corrosion has been found in our laboratories which has largely eliminated this corrosion. This treatment consists of adding about 0.25% of 28% aqueous ammonium hydroxide to the crude sulphate turpentine. This maintains both the liquid and vapor phase in an alkaline condition which seems to inhibit corrosion by the sulphur compounds. Test results of inhibiting corrosion by ammonia treatment are given in Table II.

Table II. Corrosion of Mild Steel by Ammonia-Treated Crude Sulphate Turpentine

Crude turpentine	*pH before test*	*Corrosion rate, in. per yr.* *Vapor*	*Liquid*	*pH after test*
From Same Mill				
2% of 28% NH_4OH	10.2	0.0077	Nil	10.3
1% of 28% NH_4OH	10.1	0.0089	Nil	9.7
0.5% of 28% NH_4OH	10.1	0.0084	Nil	9.9
0.25% of 28% NH_4OH	9.3	0.02%[a] wt. increase	Nil	9.7
From Different Mills				
0.25% of 28% NH_4OH	10.1	0.01%[a] wt. increase	Nil	9.7
0.25% of 28% NH_4OH	10.0	0.02%[a] wt. increase	Nil	9.8
0.25% of 28% NH_4OH	10.0	Nil	Nil	9.7
0.25% of 28% NH_4OH	10.2	Nil	Nil	8.9

[a] A thin hard film formed on surface.

For the past several months we have added 0.25% of aqueous ammonium hydroxide to all empty tank cars at our plant before their return to pulp mills for refilling. Corrosion tests on mild steel specimens in these tank cars so far indicate that practically no corrosion is taking place. These tests are being continued and complete results will be published at a later date.

Any pulp mills having large storage tanks for crude sulphate turpentine, who have encountered trouble with corrosion should find the use of a similar ammonia treatment beneficial in preventing corrosion.

It is hoped that these brief comments will be of assistance to those operating or planning sulphate turpentine recovery units.

LITERATURE CITED

1. Norton, S. G., Lowe, Gordon E., and Calhoun, George M., *Tech. Assoc. Papers* 30: 568–569 (1947).

Received May 5, 1952. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 18–21, 1952.

Studies of Variability in a Kraft Mill

HOWARD W. STEPHEN

Studies of isolated stages in pulp mill manufacture to determine limits of variability and to identify causes, using a general analysis of variance for analyzing hardness of stock and activity of white liquor and using the standard deviation to analyze fiber loss at shaker screen.

In order to maintain a kraft pulp and board mill at maximum economical efficiency, it is necessary to understand and control the quality of the finished board and of the chemical recovery. We know that the variability of a system is equal to the sum of all of the variables entering into the system, i.e.,

$$\sigma^2 T = \sigma^2 a + \sigma^2 b + \sigma^2 c \ldots \sigma^2 z$$

There are many stages in the manufacture of kraft pulp and board. Variables are introduced at each of the stages, and each variable has its effect on the final product. Therefore, elimination or reduction of any one of these variables will automatically reduce the over-all variability.

The general analysis of variance, as outlined by Brownlee (*1*), is very useful in locating causes of varia-

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Table I. Permanganate Numbers

	D_1					D_2					D_3				
	L_1	L_2	L_3	L_4	L_5	L_1	L_2	L_3	L_4	L_5	L_1	L_2	L_3	L_4	L_5
C_1	3.6	4.2	3.7	2.2	3.5	4.6	1.4	2.8	3.2	3.6	−1.3	0.8	−0.5	0.3	−0.8
C_2	0.7	1.3	0.2	−0.9	−0.1	4.8	3.7	3.7	2.3	3.1	3.0	1.2	3.9	3.9	2.7
C_3	6.4	2.2	2.1	1.8	3.8	4.1	3.2	3.7	1.9	1.6	10.0	9.5	7.0	5.5	6.5

	D_4					D_5				
	L_1	L_2	L_3	L_4	L_5	L_1	L_2	L_3	L_4	L_5
C_1	3.3	1.9	2.9	2.4	0.8	6.5	7.7	4.6	8.8	7.0
C_2	4.0	4.2	2.4	1.6	3.9	7.8	4.2	6.5	7.4	5.5
C_3	10.6	6.0	8.3	8.9	8.2	−0.6	−0.2	−0.4	0.3	1.5

D—digester. *L*—levels in digester: 1 = top; 5 = bottom. *C*—cook. *n*—permanganate number minus 25.0.

tion, thus leading to their elimination or reduction. Three studies of isolated stages in the process are given as follows:

STUDY I

Problem: To determine the limits of variability in hardness of stock and to identify causes of variation.

Data: Samples of pulp for manufacture of 16-point board were selected from three random cooks from each of five digesters, at five levels in the digester. Hardness of stock was determined in the laboratory using the TAPPI modified permanganate number method. Results are given in Table I.

Analysis: Using the three factor analysis (*1*) the data may be set up and analyzed as shown in Table II.

Conclusions:

1. Ninety-five per cent of the permanganate numbers are within the limits of 22.9 to 34.3. The mean permanganate number is 28.6.

2. Variability in the process is identified as follows:

(a) Imperfect circulation within a digester has a tendency to form levels of different hardness. The variation $\sigma^2 L$ is significant and equal to 0.16 or 1.9% of the total variation.

(b) Nonuniformity in cooking in all digesters and all cooks is due to factors common to all digesters and dependent upon time. These factors may be kind of chips used, concentration of alkali per unit of dry chips, cooking time and temperature, and sulphide concentration of the cooking liquor. The variation $\sigma^2 c \times d$ is significant and equal to 6.84 or 80.9% of the total variation.

(c) The residual variability is that which is not

Table II. Calculations

Source of variance	*Degrees of freedom*	*Sum of squares*	*Mean square*	*Comp. of variance*
Between levels	4	15.25	3.81	$\sigma^2 o + D\sigma^2 lc + C\sigma^2 ld + CD\sigma^2 l$
Between cooks	2	28.98	14.49	$\sigma^2 o + L\sigma^2 cd + D\sigma^2 cl + LD\sigma^2 c$
Between digesters	4	54.23	13.56	$\sigma^2 o + C\sigma^2 dl + L\sigma^2 dc + LC\sigma^2 d$
$L \times C$ interaction	8	9.16	1.15	$\sigma^2 o + D\sigma^2 lc$
$C \times D$ interaction	8	416.33	52.04	$\sigma^2 o + L\sigma^2 cd$
D × L interaction	16	19.11	1.19	$\sigma^2 o + C\sigma^2 dl$
Residual	32	53.66	1.65	$\sigma^2 o$
Total	74	596.72		

Comparing:

$L \times C$ int. with residual:
$1.15 < 1.65$ ∴ Not significant; $D\sigma^2 lc = 0$
$1.19 < 1.65$ ∴ Not significant; $C\sigma^2 dl = 0$

Comparing:

Between C with $C \times D$ int.:
$14.49 < 52.04$ ∴ Not significant $LD\sigma^2 c = 0$
$13.56 < 52.04$ ∴ Not significant $LC\sigma^2 c = 0$

New residual = 1.46 with 56 degrees of freedom

New $C \times D$ int. = 35.68 with 14 degrees of freedom

Compare: L with residual = 3.81/1.46 = 2.61 (4,56) ∴ Significant at 5%
$\sigma^2 l = 0.16$

$C \times D$ int. with residual = 35.68/1.46 = 24.4 (14,56) ∴ Significant at 0.1%
$\sigma^2 cd = 6.84$

Total variance of process: $\sigma^2 T = 1.46 + 0.16 + 6.84 = 8.46$
$\sigma T = 2.91$

Mean permanganate number = 28.6
Limits (95%) of variance = $28.6 \pm 1.96 \times 2.91$
= 22.9 to 34.3

Table III. Per Cent Activity of White Liquor

	C_1									C_2								
	T_1			T_2			T_3			T_1			T_2			T_3		
	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
	−2.0	−2.0	0.2	1.7	2.5	1.9	1.3	3.3	0.2	3.8	3.3	7.5	4.8	−0.5	3.7	−2.1	1.8	2.8
	1.5	5.0	7.5	2.0	0.9	1.5	1.6	2.5	1.8	2.0	1.8	5.4	−1.0	4.2	5.7	3.8	2.3	5.7
	1.0	3.9	2.9	−1.0	4.1	2.6	−2.1	6.3	1.6	5.5	2.3	4.3	3.3	4.1	4.3	1.7	2.4	2.8

	C_3									C_4								
	T_2			T_2			T_3			T_1			T_2			T_3		
	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
	2.0	2.7	5.0	4.3	4.2	2.8	1.4	1.4	4.3	3.8	4.2	5.8	−0.8	2.7	4.8	1.7	3.9	4.8
	3.9	4.7	3.4	0.2	2.6	6.2	4.3	4.3	5.2	0.8	2.3	4.8	3.3	3.9	4.3	3.8	2.3	−0.9
	3.8	3.9	4.2	3.0	2.9	2.1	2.6	3.8	2.2	2.0	1.6	4.2	−0.1	1.0	5.5	5.4	3.4	3.8

C—operating crews, nos. 1, 2, 3, 4. T_1—total titration, 19.1 to 20.0 ml. T_2—total titration, 20.1 to 21.0 ml. T_3—total titration, 21.1 to 22.0 ml. S_1—sulphide, 20.1 25%. S_2 sulphide, 25.1 30.0%. S_3—sulphide, 30.1-35.0%. *n*—per cent activity minus 80.0%.

Table IV. Calculations

Source of variance	Degrees of freedom	Sum of squares	Mean square	Comp. of variance
Between C	3	36.61	12.20	$\sigma^2o + A\sigma^2cts + AT\sigma^2cs + AS\sigma^2ct + ATS\sigma^2c$
Between T	2	6.66	3.33	$\sigma^2o + A\sigma^2cts + AC\sigma^2ts + AS\sigma^2tc + ASC\sigma^2t$
Between S	2	59.28	29.64	$\sigma^2o + A\sigma^2cts + AC\sigma^2ts + AT\sigma^2cs + ACT\sigma^2s$
$C \times T$ interaction	6	8.16	1.36	$\sigma^2o + A\sigma^2cts + AS\sigma^2ct$
$T \times S$ interaction	4	14.70	3.68	$\sigma^2o + A\sigma^2cts + AC\sigma^2ts$
$S \times C$ interaction	6	23.81	3.97	$\sigma^2o + A\sigma^2cts + AT\sigma^2sc$
$S \times T \times C$ interaction	12	31.30	2.61	$\sigma^2o + A\sigma^2cts$
Residual	72	259.85	3.61	σ^2o
Total	107	440.37		

Compare T, $C \times T$, $T \times S$, $S \times C$, $S \times T \times C$, resp. with residual $\therefore$ Not significant
$\therefore ASC\sigma^2t, AS\sigma^2ct, AC\sigma^2ts, AT\sigma^2sc, A\sigma^2stc = 0$

New residual = 3.38 with 102 degrees of freedom

Compare: C with residual = 12.20/3.38 = 3.61 (3,102) $\therefore$ Significant at 5%
$\sigma^2c = 0.33$
S with residual = 29.64/3.38 = 8.76 (2,102) $\therefore$ Significant at 0.1%
$\sigma^2s = 0.73$

Total variation of process: $\sigma^2T = 3.38 + 0.33 + 0.73 = 4.44$
$\sigma T = 2.11$

Mean per cent active = 82.9%
Limits (95%) of variance = 82.9% ± 1.96 × 2.11
= 78.7 to 87.0%

Mean values of:
$C_1 = 81.9\%$
$C_2 = 83.2\%$
$C_3 = 83.4\%$
$C_4 = 83.0\%$
$\therefore C_1$ significantly different

Mean values of:
$S_1 = 81.9\%$
$S_2 = 82.9\%$
$S_3 = 83.7\%$
$\therefore$ Not significantly different. However S_2 is most desirable

detected by analysis. Closer study using factors other than digesters and levels would probably reveal the additional causes. The variation σ^2r is equal to 1.46 or 17.2% of the total variation.

3. There is no significant variation between digesters, nor between cooks in a particular digester.

STUDY II

Problem: To determine the limits of variability in per cent activity of white liquor.

Data: One hundred and eight liquor cooks were tested at the dissolving tank for total alkalinity. These cooks were then causticized and later tested at the settling tanks for per cent sulphide and per cent activity. Data were tabulated according to operators, total titrations, and per cent sulphide to determine each effect on the final per cent activity. Data are given in Table III.

Analysis: Using the three factor analysis with replication (*1*), the data may be set up and analyzed as shown in Table IV.

Conclusions:

1. Ninety-five per cent of the white liquor is within the limits of 78.7 to 87.0% activity. The average activity is 82.9%.

2. Variability in the process is identified as follows:

(a) Most of the variability has not been identified by the analysis. Closer study holding recovery furnace operating conditions at various levels would probably reveal the additional causes. The residual variation σ^2r is equal to 3.38 or 76.1% of the total variation.

(b) The sulphide content of the liquor has a small but significant effect on the final activity. A control of

Table V. Total Rejects and Good Fiber over Shaker Screen

Total rejects and good fiber, tons per day	Good fiber, tons per day
4.00	1.20
3.00	0.65
7.70	1.20
4.35	0.65
5.85	2.05
3.65	0.75
2.25	1.20
3.15	0.50
3.75	0.23
3.20	0.75
7.35	1.35
2.70	0.25
1.15	0.10
2.00	0.45
2.95	0.50
ΣX 57.05	11.83
N 15	15
$\bar{X}$ 3.80	0.79
ΣX^2 265.38	13.14
$(\Sigma X)^2/N$ 217.00	9.35
$\Sigma' X^2$ 48.38	3.79
σ^2 3.46	0.27
σ 1.86	0.52

Table VI. Calculations

Total Rejects and Good Fiber

Limits of population mean (95%) = 3.80 ± 2.15 × (1.86/ $\sqrt{15}$)
= 3.80 ± 1.03 tons per day
Upper limit = 4.83 tons per day
Lower limit = 2.77 tons per day
Limits of population (95%) = 3.80 ± 1.96 × 1.86
= 3.80 ± 3.64
Upper limit = 7.44 tons per day or 10.3 lb. per min.
Lower limit = 0.16 ton per day or 0.2 lb. per min.

Good Fiber

Limits of population mean (95%) = 0.79 ± 2.15 × (0.52/ $\sqrt{15}$)
= 0.79 ± 0.29
Upper limit = 1.08 tons per day
Lower limit = 0.50 ton per day
Limits of population (95%) = 0.79 ± 1.96 × 0.52
= 0.79 ± 1.02
Upper limit = 1.81 tons per day or 2.5 lb. per min.
Lower limit = 0 tons per day or 0 lb. per min.

sulphide to within limits of 25 to 30% is desirable. The variation $\sigma^2 s$ is equal to 0.73 or 16.5% of the total variation.

(c) There is a small but significant difference between operators. Liquor made by crew no. 1 is significantly lower in activity than that made by the other three crews. The variation $\sigma^2 c$ is equal to 0.33 or 7.4% of the total variation.

3. It is possible to let the total alkalinity vary from 19.1 to 22.0 ml. without affecting the per cent activity. A variation in total alkalinity will certainly have an effect on the causticizing operation. However, this effect is being compensated for by the operators.

STUDY III

Problem: To determine the limits of variability in rejects and good fiber passing the shaker screen.

Data: Fifteen samples of rejects and good fiber were obtained from the shaker screen. These samples were analyzed for per cent rejects and per cent good fiber by standard laboratory methods. Flow measurements of rejects and good fiber across the shaker screen were obtained by standard methods. Data are shown in Table V.

Analysis: Limits of population mean and population were calculated from variance and standard deviation. Data are shown in Table VI.

Conclusions:

1. The mean amount of rejects and good fiber passing over the shaker screen is equal to 3.80 ± 1.03 tons per day. The flow is not uniform the population may vary from 0.2 to 10.3 pounds per minute.

2. The mean amount of good fiber passing over the shaker screen is equal to 0.79 ± 0.29 ton per day. The flow is not uniform, the population may vary from 0 to 2.5 pounds per minute.

LITERATURE CITED

1. Brownlee, K. A., "Industrial Experimentation," 3rd ed., chap. XI, page 86, Brooklyn, N. Y., Chemical Publishing Co., Inc., 1949.

Received Feb. 15, 1952.

Improved Diffuser Washing—Markila-Brax Strainers and Angle Iron Supports

K. F. GOTHNER and H. T. ROBSON

Washes were made in two differently dimensioned groups of diffusers which differed mainly in diameter. The unchanged diffusers were compared with two modifications—Markila-Brax strainers, a Finnish invention, and crossed angle iron supports. Both of these modifications of conventional diffuser design operate on the principle of relieving the pressure of the pulp against the screens, and both were found to be effective, especially in the narrower unit. The Markila-Brax strainers reduced the washing time 58% on the diffuser with the smaller diameter and 29% on the other. The angle iron supports reduced the washing time 21% on the narrower diffuser and 13% on the other. The quality of washing was about the same in all cases, the soda loss amounting to about 20 lb. of Na_2SO_4 per ton of pulp. Data on underflow dilution were contradictory; there is perhaps no significant change in underflow dilution when a diffuser is modified with either invention.

In order to study the possibility of increasing the washing capacity of 40 existing diffusers at the Union Bag & Paper Corp. plant in Savannah, Ga., experimental installations of Markila-Brax strainers and crossed angle iron supports were made in two groups of diffusers of different dimensions. The first group of these is 12 ft. in diameter and 29 ft. tall and will hereinafter be referred to as no. 1 unit; the second group is 13 ft. in diameter and 26 ft. tall and will be referred to as no. 2 unit. All hold one blow from our 2730-cu. ft. digesters, or about 8.3 tons of stock. Both modifications of conventional diffuser design were tried out in each unit.

Both installations operate on the principle of relieving the pressure against the bottom screen and both were remarkably successful in reducing washing time. The crossed angle irons installed in a diffuser are shown in Fig. 1. This arrangement employs two pieces of 6 by 6-in. angle iron welded to the shell on the ends and crossed prependicularly at the center of the diffuser where a vertical support is provided. They are installed 5 or 6 ft. above the diffuser bottom. To aid in dumping diffusers equipped with this device, three nozzles were installed in the shell opposite the dumping door and were used in addition to the conventional hand dumping hose. The Markila-Brax system for diffuser washing uses vertical strainers arranged as shown in Fig. 2. A simplified sketch of one of the six strainers of our installation is shown in Fig. 3. The screens on the side of the strainers are identical with the bottom screens of the diffuser. The first part of the liquor is drained off through the strainers only, then the washing is continued to completion by draining the liquor entirely through the bottom screen. In order to make the dumping easier, nozzles for dumping water were installed below each strainer, but were found to be unnecessary when a Sandberg valve was used.

The Sandberg valve, a device for automatic dumping of diffusers, is shown in Fig. 2 in the open position. The opening and closing of the valve are done by a lever arm underneath the diffuser. This lever arm can be manually or automatically operated. In the open posi-

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tion, the cone, the shaft, and the two nozzles are rotated by a 1-hp. motor at a speed of 2 r.p.m. Water, which is pumped to the valve at 300 g.p.m. and 300 p.s.i., sprays through the two nozzles radially over the bottom

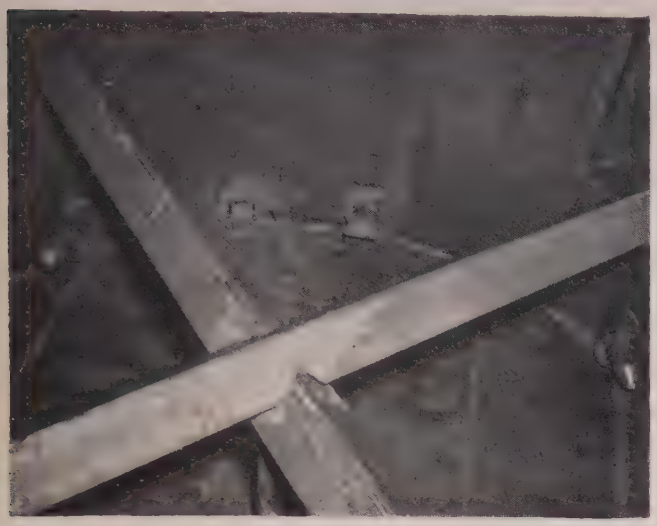

Fig. 1. Angle iron installation

of the diffuser, flushes the pulp out through the valve, and cleans the strainers and the bottom screens. In order to use this valve the diffusers must be equipped with a conical bottom having an apex angle of about 138°.

EXPERIMENTAL PROCEDURE

In determining washing times regular operating practices were followed as closely as possible. Cushion liquor was backed up into the empty diffuser before the blow, and an initial weak liquor wash was used for 30 min. However, since both of these practices introduce undesirable variables in the underflow volume measurement, another group of washes was made for this purpose in which neither cushion liquor nor an initial weak liquor wash was used. In operating the Markila-Brax diffusers, only the strainers were used until the specific gravity of the liquor was about 2° Baumé at the operating temperature, then only the bottom screens were used until the end of the wash. For all diffusers the change from hot wash water to cold wash water was made when the specific gravity of the underflow was 5° Baumé at the operating temperature.

At least ten washes of every type were made. All washes comparing conventional diffusers with modified diffusers were made simultaneously. A record was kept of the starting and finishing times of the washing and dumping, and every 15 min. a record was made of the following: the Baumé and temperature of the underflow; the pressure and temperature of wash liquid; the type of wash liquid being used; and either the level in the underflow receiver or the reading of the orifice meter, depending upon which method was used to measure underflow.

The kraft pulp washed in these trials was from southern pine, cooked for about 2 hr. to a permanganate number of 27, with the exception of one group of washes on no. 2 unit, where stock with a permanganate number of 34 was used. Permanganate numbers were determined for each wash at the start of the investigation. There was so little variation in permanganate numbers between washes that it was felt unnecessary to determine the permanganate number of every wash, and the tests were discontinued. However, if visual inspection of the washed pulp showed that the pulp had been poorly cooked, data from these washes were discarded.

WASHING TIME

The diffusers equipped with the Markila-Brax strainers and those equipped with crossed angle irons all achieved remarkable reductions in washing time as compared with unmodified diffusers. These reductions are shown in Table I and Fig. 4. The Markila-Brax strainers reduced the washing time 58% on no. 1 unit and 29% on no. 2 unit, while the angle irons reduced it 21% on no. 1 unit and 13% on no. 2 unit. All of the above figures are an average of the results of ten or more washes.

Table I. Comparison of Experimental Washing Times for Conventional and Modified Diffusers

	No. 1 unit		*No. 2 unit*	
	Markila-Brax	*Angle iron*	*Markila-Brax*	*Angle iron*
Washing time, hr., and min.				
Conventional	8:35	8:35	6:24	5:29
Modified	3:35	6:47	4:34	4:45
Reduction, %	58	21	29	13

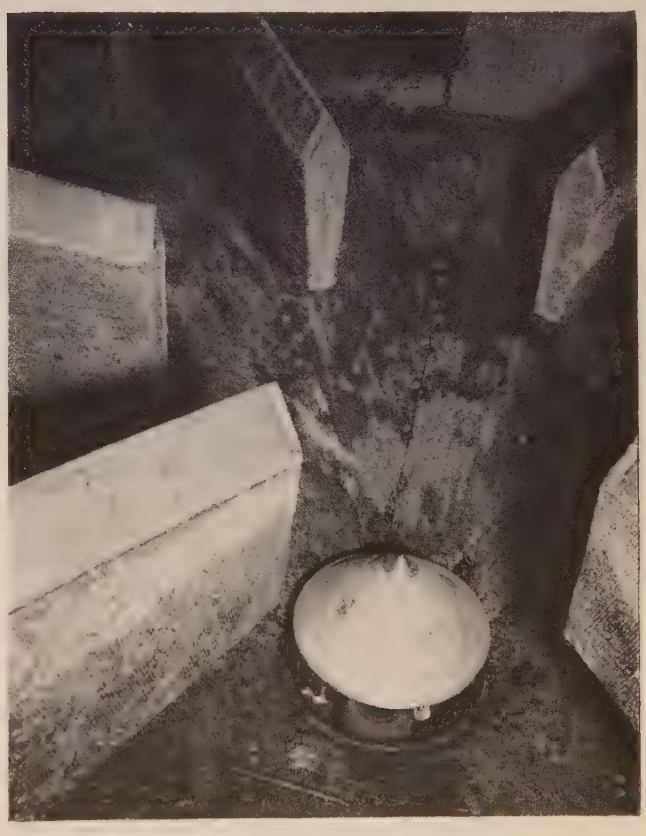

Fig. 2. Arrangement of Markila-Brax strainers and Sandberg valve

It is very evident that both modifications were more effective in no. 1 unit. This is reasonable in view of the fact that both operate on the principle of relieving the pressure against the bottom screens. The diffusers of no. 2 unit are 13 ft. in diameter as compared with 12 ft. for no. 1 unit. The weight of the stock washed in both units is the same, therefore, without any modification, the pressure against the bottom screens of no. 2 unit is less. With the Markila-Brax strainers installed, the average washing times on no. 1 and no. 2 units were 3 hr. and 35 min. and 4 hr. and 34 min., respectively. Experience shows that the ease with which pulp washes varies greatly from time to time, and the fact that the two series of washes were not made simultaneously may account for the unexpected longer time on no. 2 unit.

The increased washing speed which can be achieved with the use of Markila-Brax strainers is not an effect of increased filtering surface area. The Markila-Brax strainer surface area was only 62% of the bottom area on no. 1 unit and 57% on no. 2 unit. When the Markila-Brax strainers were used, the bottom screens were not used, and vice versa, so at no time was a greater screen surface area in use than was the case in the conventional wash. A few washes were made using both the Markila-Brax strainers and the bottom screens at the same time, but no beneficial effect was noticed.

One aspect of the washing procedure used in these trials put the Markila-Brax strainers at a slight disadvantage. In the washes used to determine washing time and operating capacity, the washing liquid was weak black liquor for the first 30 min. of the wash. Since the diffuser equipped with Markila-Brax strainers washed faster than the conventional ones, a greater amount of black liquor was recycled in the same length of time. Increasing the amount of black liquor recycled lengthens the washing time, thus tending to made the figures for the reduction in washing time slightly conservative.

All of the above figures are based on washes of stock with a permanganate number of 27. One trial was made on no. 2 unit using stock with a permanganate number of 34. This trial compared a conventional diffuser with one equipped with crossed angle irons. The washes in the latter were completed in 19% less time. This was a greater reduction than the same diffuser was able to accomplish with soft stock. No further attempt was made to determine the effect of hardness of stock on the efficacy of the two modifications.

DUMPING METHODS

The time required for dumping all the experimental washes was recorded. The average dumping time on conventional diffusers and diffusers equipped with angle irons (including opening and closing the dump door) was found to be about 25 min. on both units.

Because of the manner in which Markila-Brax strainers are located in a diffuser, it is difficult to dump such a diffuser by the conventional method. Therefore, the Markila-Brax diffuser in no. 1 unit was equipped with a Sandberg dumping valve, previously described. This valve not only eliminates a dangerous and unpleasant occupation, but also cleans the diffuser more thoroughly than any other method tried. During 15 trials with the valve, the dumping times of the Markila-Brax equipped diffuser were in the range of 15 to 30 min., with an average of 22 min.

Another possible method of dumping a diffuser is to flush the pulp out the dumping door by means of a hose from the top of the diffuser. This could be used on any of the three types of diffusers discussed here. It is safer and more comfortable than the conventional method but also slower. This technique was used on the Markila-Brax diffuser of no. 2 unit because it would have been unduly difficult to install a Sandberg valve. Top dumping was found to require an average time of 48 min., over twice that required by the Sandberg valve. The additional time required by this method is a serious drawback both from the standpoint of production capacity and labor costs, but the method was otherwise satisfactory.

INCREASES IN CAPACITY

Based on the experimental washing and dumping times, the capacity increases resulting from the various possible installations were estimated The results are summarized in Table II, where it can be seen that the capacity increase resulting from the use of Markila-Brax strainers varied from 24%, using top dumping on no. 2 unit, to 108%, using automatic dumping on no. 1 unit. Use of the angle iron supports resulted in an increase of from 12 to 22%.

Table II. Percentage Increases in Capacities over Conventional Diffusers

Diffuser type	*No. 1 unit*	*No. 2 unit*
Markila-Brax with Sandberg valve	108	33[a]
Markila-Brax with top dumping	90[b]	24
Angle irons	22	12

[a] Dumping time assumed to be 22 min.
[b] Dumping time assumed to be 48 min.

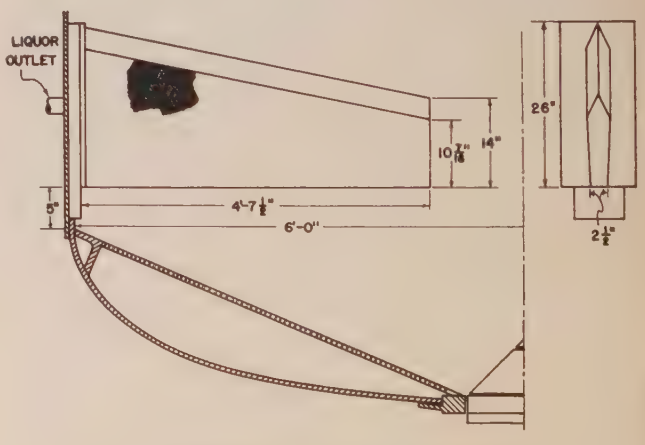

Fig. 3. Markila-Brax strainer installation

VOLUME OF UNDERFLOW LIQUOR

In order to evaluate the effect of the different washing systems on liquor dilution, which in turn has an effect on the amount of water to be evaporated and on sewer

losses, the volume of underflow liquor was measured. Orifice meters were used for most of the trials. An average of about ten measurements in each case showed that there was a diminution of underflow volume of about 10% from both of the modified diffusers of no. 1 unit, as compared with an unmodified diffuser. On the other hand, the crossed angle iron diffuser on no. 2 unit showed an 11% increase.

It was felt that the use of orifice meters did not give sufficient accuracy for these measurements. Accordingly, before the trials were made comparing a Markila-Brax diffuser with a conventional diffuser on no. 2 unit, the piping of these two diffusers was arranged in such a way that all the underflow could be collected and measured in other diffusers which then acted as receiving tanks. It is believed that this method gave the greatest possible accuracy. Water was the only wash liquid used for all washes where the underflow volume was measured by the above method.

It was found that the underflow volume from the Markila-Brax diffuser was 6% greater than from the unmodified diffuser. However, statistical analysis showed that this difference could have been due to chance variation in sampling and was therefore not significant.

The results of the volume measurements obtained by the use of the receivers are shown in Fig. 5, which shows the variation of the specific gravity of the underflow leaving the diffuser with the volume of underflow. It is apparent that the Markila-Brax strainers do not affect the dilution. That is, the concentration-volume relationship of the underflow is the same for both modified and conventional diffusers. Thus it would not be expected that the amount of liquor (per ton of pulp) sent to the evaporators and to the sewer would change if Markila-Brax strainers were installed, provided that the same volume of weak black liquor were recycled.

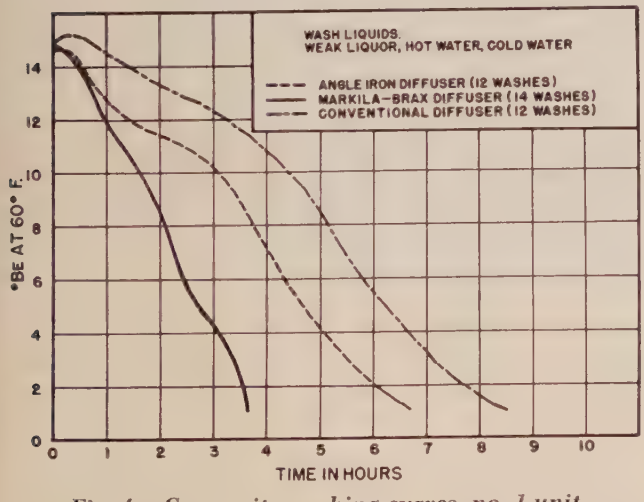
WASH LIQUIDS
WEAK LIQUOR, HOT WATER, COLD WATER
ANGLE IRON DIFFUSER (12 WASHES)
MARKILA-BRAX DIFFUSER (14 WASHES)
CONVENTIONAL DIFFUSER (12 WASHES)
°BE AT 60° F.
TIME IN HOURS

Fig. 4. Composite washing curves, no. 1 unit

However, if in a given situation the use of the strainers should result in a potential capacity increase greater than actually needed, then the amount of black liquor recycled could be increased. As a result, less liquor need be sent to the sewer.

QUALITY OF WASHING

From all appearances, the pulp washed in all of the experimental diffusers was equally clean. To demonstrate that the experimental washes were as thorough as the usual pulp mill washes, samples of the washed pulp were taken from all the diffusers and analyzed for residual soda by the uranyl zinc acetate method (T 623 m-44). The experimentally washed pulp was analyzed for soda content for only enough washes to give

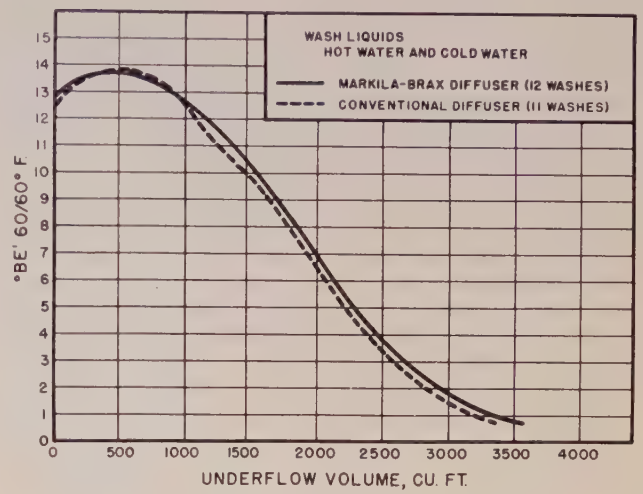

Fig. 5. Composite underflow volumes, no. 2 unit

an assurance that this pulp was being as well washed as our regular production, after which the analyses were discontinued. Averaging the results from each kind of diffuser, the soda left in the pulp in all cases was about 20 lb. per ton. In normal mill operation the soda left in the pulp is about 22 lb. per ton from diffusers and 43 lb. per ton from pulp washers.

CONCLUSION

Means have been found whereby substantial increases in diffuser washing capacity can be obtained by modifications of conventional diffuser design without adversely affecting washing quality or underflow dilution. Capacity increases as great as 22% may be obtained at low initial expense by the installation of crossed angle iron supports. Increases as high as 108% may be realized by the installation of Markila-Brax strainers. When such a large increase can be obtained, added washing capacity can be installed at a far lower unit cost by installing the strainers in existing diffusers than by installing new pulp washers. However, the prediction of what capacity increase can be expected from Markila-Brax strainers appears to be very difficult because the configuration of the diffuser into which they are installed is apparently so critical. Also the washing pressure and the permanganate number of the stock may have considerable effect. Considerable additional study would be required before a detailed prediction of the performance of Markila-Brax strainers in a given situation could be made with confidence.

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Dye Adsorption on Wood Pulp

I. Adsorption of Direct Dye on Unbeaten Sulphite Pulp

J. W. BEAMESDERFER, E. F. THODE, A. J. CHASE, and R. E. HUBBARD, JR.

In an attempt to develop a simple and rapid method for the evaluation of the specific external surface of pulp fibers, a study was made of the adsorption of a direct dye on fibers from dilute aqueous solutions. Isotherms at 25°C., for the adsorption of Benzo Fast Scarlet on unbeaten fibers from bleached sulphite pulp, are presented. Specific adsorption of dye (milligrams of dye adsorbed per gram of dry pulp) was plotted as a function of final dye concentration and isotherms of the Langmuir type were obtained. From a knowledge of the saturation value in the adsorption process, as determined from the isotherm, and from a knowledge of the area of the dye molecule presented for adsorption, calculation of an "apparent" area of the fibers is possible. An attempt was made to separate the process of adsorption on the external surface of the fibers from the slower process of diffusion of dye into the microscopic and submicroscopic pores and crevasses. Results are presented on experiments designed to give information concerning the effect of electrolyte concentration. A comparison of apparent specific surface of fibers obtained by this dye adsorption method with areas obtained by the well-known silvering and liquid permeability methods is presented.

THE take-up of direct dyes from aqueous solution by cellulose fibers has been the subject of study by many investigators primarily interested in the phenomenon of dyeing or coloring of the fibers. In the vast majority of such cases the investigators have been interested in conditions that will promote the maximum take-up of dye by the fibers. It is recognized, in view of the proposed structure of most cellulosic fibers, that penetration of dye into fibers renders very difficult any attempt to study the adsorption of dye on the external surface of fibers. E. Heuser (*1*) describes the *ab*sorption of direct dyes from aqueous solutions as follows:

"...The capillary system of the fiber on the one side and the particle size of the dye molecules on the other are of great importance because the dye molecules must penetrate the capillaries to reach the interior of the fiber, and only dyes of sufficiently small particle size can enter the finer and finest capillaries. Even in the swollen state, which is a prerequisite for dye absorption, the chains within the crystalline regions of the micellar system are probably packed too closely to be reached by the common dye molecules; for this reason penetration is generally limited to the amorphous regions. The dye is evidently absorbed not only on the surface but is distributed through the whole fiber...."

For these two reasons, lack of interest and difficulty of experimentation, the number of researches concerned with adsorption of dyes on the external surface of wood pulp fibers have been rather limited.

In the pulp and paper field, the work of Clark (*2*) and others has stimulated considerable interest in the evaluation of the external surface of pulp fibers. A number of investigators feel that the evaluation of specific external surface of fibers may be of greater basic value in interpreting or predicting fiber behavior in papermaking than is some such derived property as the freeness. The evaluation of specific external surface may be accomplished by various means, including techniques such as optical examination, measurements of specific chemical or catalytic reactivity, liquid permeability, gas permeability, gas adsorption, and adsorption from solution.

The optical examination method suffers from such obvious drawbacks as the extreme difficulty of evaluating the surfaces of irregular fibers and the uncertainty of observation at high magnification in an aqueous medium. The technique of an individual experimenter may be so highly developed as to make the method valid, for unbeaten fibers at least, but the laborious nature of the method precludes its widespread applicability.

J. d'A. Clark (*2*) made the first significant contribution of a widely applicable method for surface measurement by employing an artificially induced, specific catalytic activity of the fiber surface. The Clark silvering method as modified by Browning and Baker (*3*, *4*) gives good comparative results on beaten and unbeaten pulps and is considered to be well standardized. This method of evaluation, however, involves a very long and tedious laboratory operation; the procedure requires skilled operators with a highly developed and well-standardized laboratory technique.

More recently, S. G. Mason and co-workers (*5*) have developed a liquid permeability method for specific surface evaluation of cellulose fibers. The method is relatively rapid and with some practice in pad formation yields reproducible results.

Gas permeability and gas adsorption methods suffer one disadvantage in common; namely, the fibers to be measured must necessarily be dry. Most workers are confident that the surface characteristics of shrunken, dry fibers are far different from those of swollen, wet fibers. True enough, it is possible to prepare dry fibers without shrinking, but here again the method of accomplishing this is laborious. In addition to the above disadvantage, the gas adsorption method would, in view of the relatively small molecules adsorbed, determine not the external surface alone but the internal surface of the fiber as well.

In pursuing a logical review of the situation, one now reaches the question of the possibility of determining the specific external surface of pulp fibers by adsorption from solution. C. S. Heustis (*6*) briefly investigated

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the change in adsorption of Benzopurpurin on pulp fibers brought about by beating of fibers. Hess and Gramberg (*7*) have shown that considerable amounts of Congo red are adsorbed by various wood pulps, that the adsorption increased with increased beating of the fibers, and that adsorption varied with various pretreatments of fibers. Stamm and Millet (*8*) have estimated the "microscopically visible capillary surface" of filter paper and sugar pine by selective adsorption of stearic acid from benzene.

From investigations such as that conducted by Hess and Gramberg (*7*) it appears that certain direct dyes are adsorbed from aqueous solution to a large extent by pulp fibers and that the adsorption can be represented by Langmuir-type isotherms. It is immediately apparent that a dye adsorption method of evaluating specific external surface of pulp fibers would have to be calibrated in some manner, since one cannot determine just what portion of the surface is covered by solute molecules and what portion by solvent molecules. In the investigation of Stamm and Millet (*8*) it was reported that the solvent was selectively adsorbed from alcohol solutions and from acetone solutions of stearic acid. In spite of the fact that the method certainly falls short of the ideal, in not being an absolute method, it has potentially a virtue possessed by none other to the same degree; the laboratory determination can be performed quite rapidly and simply without recourse to laborious computation. If the determination of the external surface of pulp fibers is ever to become a technical control method in industry, such a consideration is paramount.

It is the ultimate objective of the entire program of investigation, of which this paper reports a part, to develop a rapid method for the determination of specific external surface of pulp fibers, using the technique of adsorption from solution, that will yield good comparative values. The objective of the first part of the program was to obtain basic information relating to the adsorption of direct dye from solution on unbeaten wood pulp fibers.

Many investigations have been reported in which specific surface areas of materials other than cellulose have been determined by adsorption from solution. In these investigations, isotherms of the Langmuir type were obtained. The determination of the area of the adsorbent depends upon (1) a knowledge of the area effectively covered by a molecule of the adsorbate, (2) the selection of a point on the Langmuir-type isotherm which corresponds to a monomolecular coverage by the adsorbate molecules, and (3) the assumption that no appreciable number of solvent molecules are present in the adsorbed layer. The area effectively covered by a molecule of the adsorbate is usually taken as that area which is covered by the oriented molecule in a compressed film on water. Fatty acids are often used for surface area determinations since their effective molecular areas have been so determined. The point on the isotherm which corresponds to a monolayer of adsorbed molecules is generally taken as the saturation value of adsorption as shown by the horizontal portion of the isotherm.

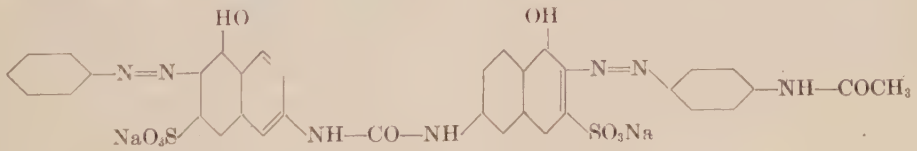
When the adsorption of a solute from solution is determined by measuring the concentration change of the solute, the adsorption is always an apparent adsorption since some solvent molecules will be adsorbed simultaneously. The real amount adsorbed may differ considerably in some cases from the apparent amount adsorbed. It follows also that when the solution consists of a small amount of strongly adsorbed solute and a large amount of solvent which is only slightly adsorbed the difference between apparent and real adsorption will not be very great. In the case of porous materials it must also be realized that the area determined will depend upon the area available to the adsorbed molecules which in turn depends upon the relation between the size of the adsorbed molecules and the size of the pores. It seems probable that dye adsorption occurs principally on certain active groups of the surface rather than uniformly over the entire surface. If the surface of the adsorbent consists very largely of active groups then the dye adsorption method may come close to determining the total surface area of the adsorbent.

In the case of adsorption of dye on cellulose the factor of electrolyte concentration must also be considered, since it is known that the addition of salts to dye baths affects the amount of dye adsorbed. The time factor is not to be overlooked, since over a prolonged period of time the dye will penetrate by diffusion into spaces within the fiber itself. The effect of the various factors mentioned above on the specific external surface determination will be discussed, but it becomes obvious that the area determined must be termed an "apparent" area. It seems logical that if the results of "apparent" area determinations are reproducible on various pulp samples, then this "apparent" area should be directly related to the real external area of the fibers.

INVESTIGATIONAL PROCEDURE

Calculation of Area of Dye Molecule

The area effectively covered by the adsorbed dye molecule used as the "measuring stick" must be determined. Since only the external area of pulp fibers is to be determined, the selection of a dye which will not too readily penetrate into spaces within the fiber is important. The dye selected for this investigation was Benzo Fast Scarlet 4BSA (General Dyestuff Corp). The molecular weight is 813 and the structural formula as commonly presented is as follows:



Pauling (*9*) and others have employed data from x-ray diffraction, band spectroscopy, and electron diffraction to determine interatomic distances in molecules, and from such values one may calculate with fair precision the actual volume of a molecule of a given compound and the area through any section. Figure 1 is a horizontal projection of the molecule of Benzo Fast Scarlet in its flat or unfolded position. This representation was prepared using the formula

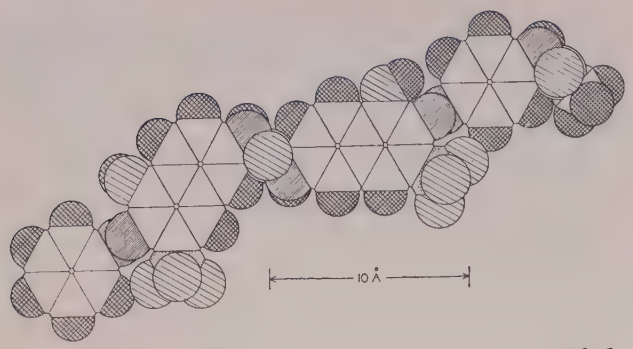


Fig. 1. Horizontal projection of the scale model of the Benzo Fast Scarlet molecule

given and the data by Pauling listed in Table I; the drawing is a plan view of a Hirschfelder-Taylor scale model of the dye molecule.

One may make various assumptions as to the degree of folding and the possibility of nesting of the molecules on adsorption. Morton (*10*) presents evidence to show that (1) direct dye *ab*sorption by cellulose can best be explained by *ab*sorption as single molecules rather than

Table I. Covalent Radii for Atoms (*Data of Pauling (9)*)

Element	*Radius, A.*
H	0.30
C (s)	0.771
C (d)	0.665
C (aromatic)	0.695
N (s)	0.70
N (d)	0.60
O (s)	0.66
O (d)	0.55
S (s)	1.04
S (d)	0.94

as micelles, and (2) in the dyed material the elongated direct dye molecules are oriented parallel to the cellulose molecular chains. An examination of the literature reveals several hypotheses regarding the types of forces operative in adsorption of direct dye upon cellulose. Van der Waals forces have been postulated.

Brunauer (*11*) states: "...Since the van der Waals energy of attraction between a molecule and a surface increases with the size of the molecule and is inversely proportional to the cube of the distance between the center of the molecule and the surface, one would expect that large molecules have a strong tendency to lie flat on the surface. This was demonstrated experimentally by Hendricks for a number of large organic molecules adsorbed on layer crystal montmorillonite...."

If one assumes the flat and unfolded position of the dye molecule to be the most probable on adsorption and further assumes that the effective area covered by the dye molecule would be that of an envelope touching the extreme radii of the constituent atoms, an area of 219 sq. A. may be calculated. The structural formula of the dye shows the possibility of geometrical isomerism about the double-bonded nitrogen atoms. The construction of the scale model shows that the phenyl groups may be in the same plane as the substituted naphthalene rings or that they may lie in a plane which is very nearly perpendicular to the plane of the naphthalene rings. Estimation of the area with the phenyl groups in the latter position yielded a value of about 141 sq. A.

Adsorption of Benzo Scarlet on Carbon

In order to check the value of the area effectively covered by a dye molecule on adsorption, as calculated from interatomic distances, adsorption experiments were carried out in which the dye was adsorbed from aqueous solution upon specially prepared carbon black of known specific surface area (*12*). Carbon black particles are commonly regarded as nonporous with smooth nonserrated surfaces. The carbon black used had been heat treated at 1000°C. *in vacuo*, and its specific surface area as determined by low temperature nitrogen adsorption was 129 sq. meters per gram. An isotherm of the Langmuir type was obtained for the adsorption of Benzo Fast Scarlet on the carbon. Samples of carbon (0.15 gram) were shaken with 25-ml. samples of dye solutions of given concentrations and a period of 24 hr. was allowed for equilibrium to be established at 25°C. Dye concentration changes in the bulk solution were determined by spectrophotometric analysis.

The specific adsorption x/m (milligrams of dye adsorbed per gram of carbon), was taken to be the same as the apparent adsorption, $V\Delta c/m$, where V is the volume of the dye solution in liters, Δc is the concentration change of the dye solution in milligrams per liter, and m is the weight of the carbon in grams. The saturation value corresponding to a monolayer of adsorbed dye was taken from the horizontal portion of the isotherm. Employing the values of (1) the number of milligrams of dye adsorbed per gram of carbon corresponding to a monolayer and (2) the known surface area per gram of carbon, the area effectively covered by a molecule of dye upon the carbon surface may be calculated.

Adsorption on Unbeaten Pulp

All the wood pulp used in this investigation was taken from a single roll of commercially prepared, bleached, calcium-base, sulphite pulp. The predominant wood species was Northern red spruce (*Picea rubens*) but various of the other native Maine pulpwood species, notably hemlock, were represented.

The dry pulp was weighed and then soaked in a sufficient volume of distilled water to yield a slurry of about 1.5% consistency. After about one-half hour soaking, the pulp was dispersed by 3 min. of agitation in a laboratory Dynopulper. After a further soaking of 24 hr., the water was drained from the pulp and the pulp pressed to about 18% consistency. The pulp was then immediately redispersed in the Dynopulper in a fresh charge of distilled water. This batchwise washing operation was repeated twice more. The washed slurry was given a final dispersing treatment at 1.3% consistency for 2 min. in a Waring Blendor.

All of the dye solutions were prepared at 20°C. using accepted gravimetric and volumetric procedure. A single sample of unloaded Benzo Fast Scarlet 4BSA-FS was used as the source of dye for all experiments. For pulp dyeing experiments a standard stock solution (approximately 1.6 grams per liter) was prepared and allowed to stand at least a week before using. The working solution for these experiments was obtained by diluting the stock solution with 9 parts of water.

A Coleman spectrophotometer was used for analysis of the dye solutions. From the *S-T* (wavelength versus

transmittance) curves for dye solutions of several concentrations, it was found that the wave length corresponding to maximum absorption was about 505 mmμ. Light of this wavelength was accordingly used throughout the investigation for analytical operations. Reference standards of dye solutions were prepared and from a set of solutions of given concentrations, prepared by dilution of each of the standards, the *C-T* curves (concentration versus transmittance) were obtained. The employment of standard dye solutions instead of pure water for comparison in the spectrophotometer permits greater accuracy and a wider working range. Analysis of a dye solution of unknown concentration was accomplished by measuring its transmittance and reading the corresponding concentration from the *C-T* curve.

Although the optical behavior of the dye solutions was not fully investigated, it seemed that for solutions exceeding about 0.04 gram per liter of dye, the analytical procedure does not give consistent results. Possibly Beers' law does not hold for solutions above this concentration because of micelle formation. No attempt was made to determine the critical concentration for micelle formation in the dye solutions. As long as observations are confined to the region in which the final (and preferably the initial) dye concentration is less than about 0.04 gram per liter, these difficulties do not seem to arise.

Adsorption on the unbeaten sulphite pulp was studied employing the following standardized procedure: a 250-ml. sample of dispersed pulp (about 1.3% consistency) was placed in a 600-ml. beaker. While gently stirring with a laboratory mixer, potassium chloride solution, water, and dye solution were added, in the order given. The volume of each ingredient added was adjusted so that the final volume of solution would always be 400 ml. A stop clock was started at the instant the dye solution began to enter the mixture. One minute before the end of the specified dyeing period, the stirrer was stopped and 10 ml. of pulp suspension were poured into each of two dry centrifuge tubes. At a time 30 sec. before the conclusion of the specified dyeing time, the centrifuge was started and the samples subjected to separation for 20 sec. at about 3300 r.p.m. At the end of the dyeing time, the supernatant colored solution was poured off directly from the centrifuge tubes to the cuvette of the spectrophotometer. All the fibers were collected in a Buchner funnel on a tared sheet of filter paper, dried, and the final weight (air dry) determined.

The concentration of the dye solution added was 0.164 gram per liter for the experiments here reported; the initial dye concentration in the dye bath was controlled by varying the amount of working solution added. The volume and concentration of potassium chloride stock solution added varied depending upon the electrolyte concentration desired in the dye bath. The specified times of dyeing were 10, 20, and 40 min.

RESULTS

Area of Dye Molecule

The isotherm for the adsorption of Benzo Fast Scarlet on carbon is shown in Fig. 2. The area effectively covered by a dye molecule upon the carbon surface was found to be 149 sq. A. This value compares favorably with the value of 141 sq. A. calculated from interatomic distances. This value of 149 sq. A. was used in subsequent calculations for estimating areas of pulp fibers.

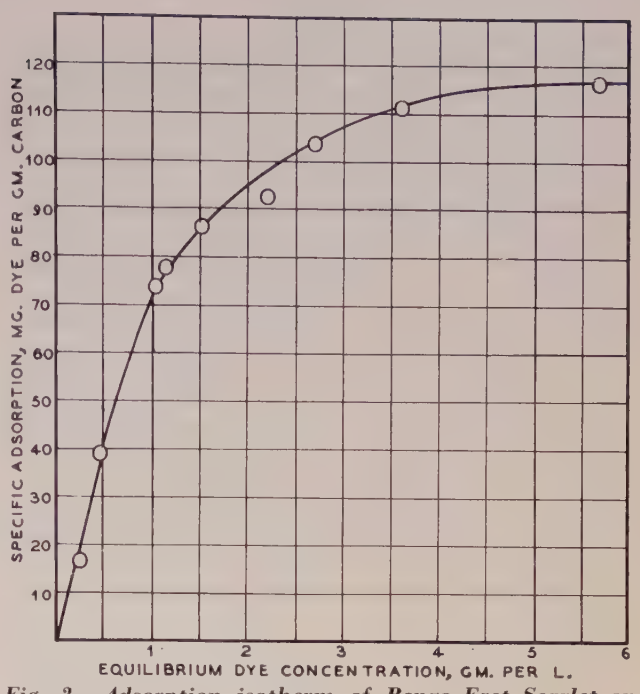


Fig. 2. Adsorption isotherm of Benzo Fast Scarlet on carbon black at 25°C.

Adsorption Experiments on Unbeaten Pulp

In Fig. 3 are drawn four experimentally obtained isotherms for adsorption of Benzo Fast Scarlet on sulphite pulp. These isotherms at 25°C. were obtained

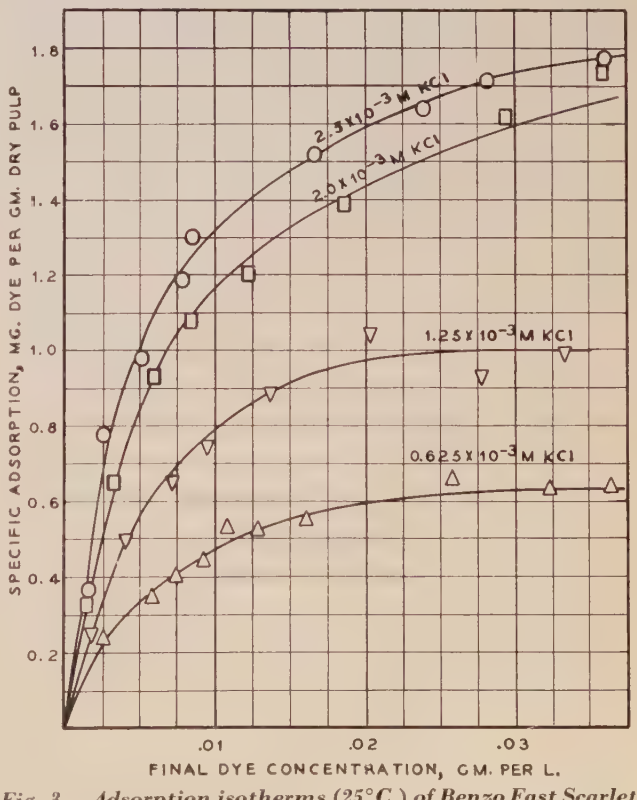

SPECIFIC ADSORPTION, MG. DYE PER GM. DRY PULP
2.5X10⁻³ M KCl
2.0X10⁻³ M KCl
1.25X10⁻³ M KCl
0.625X10⁻³ M KCl
FINAL DYE CONCENTRATION, GM. PER L.

Fig. 3. Adsorption isotherms (25°C.) of Benzo Fast Scarlet on unbeaten sulphite pulp at various electrolyte concentrations. (Dyeing time, 10 min.)

at a constant dyeing time of 10 min. Variables plotted are milligrams of dye adsorbed per gram of pulp (x/m) as ordinates versus final concentration of dye in the solution (c_f). Concentration of KCl in the solution expressed in moles per liter is the parameter. With no KCl or other electrolyte present, dye adsorption on unbeaten pulp is almost negligible. With 0.625×10^{-3} M KCl present, a fairly regular isotherm is obtained, while the use of double this concentration of KCl yields a satisfactory isotherm. Higher salt concentrations yield adsorption-dye concentration curves which do not level out within the concentration range in which reproducible results may be obtained. It was concluded that the optimum KCl concentration was in the vicinity of 1.0×10^{-3} moles per liter and such concentration was accordingly employed in the work reported in the second paper of this series.

Once the adsorption isotherm has been established for the dye on a given pulp fiber, a final dye concentration range can be determined over which specific adsorption values will correspond to adsorption saturation, that is, a final dye concentration range over which specific adsorption values fall on the horizontal portion of the isotherm can be determined. In the determination of comparative areas of various pulp samples then, it is not necessary to obtain isotherms; it will suffice to obtain one specific adsorption value corresponding to a final dye concentration within the range indicated.

If one uses the best area of the dye molecule previously determined, apparent surface areas by dye adsorption may be calculated. These "areas" will of course vary with electrolyte concentration. It is interesting to note in Table II, where these apparent areas by dye adsorption are contrasted with apparent areas obtained on the same pulp by the silvering method and the permeability method, that the electrolyte concentration arbitrarily chosen from adsorption considerations yields a surface area figure in fair agreement with those obtained by the other methods.

Table II. Apparent Surface Areas of Unbeaten Sulphite Pulp By Various Methods

Method	*Concentration of KCl, moles per liter*	*Apparent surface area, cm.² per gram*
Silvering (*4*)	...	12,000
Water permeability (*5*)	...	15,000
Dye adsorption	0.00	600
Dye adsorption	0.625×10^{-3}	7,500
Dye adsorption	1.00×10^{-3}	10,500
Dye adsorption	1.25×10^{-3}	11,500

The effect of dyeing time upon specific adsorption (at constant electrolyte concentration, 1.25×10^{-3} M KCl) is displayed by the isotherms in Fig. 4. Since the take-up of dye will involve diffusion of the dye into both microscopic and submicroscopic pores, crevasses, and interlamellar spaces of the fibers as well as adsorption on the external surface, a progressive take-up with time may be expected.

DISCUSSION

It is apparent that, as initially postulated, the dye adsorption method does not give an absolute measure of external surface area. The question involved in analyzing the data at hand is whether or not any orderly method of evaluating surface area can be evolved by appropriate calibration and by empirical limitations. While the area of the sulphite pulp used has not been determined by any absolute method, the figures of 12,000 sq. cm. per gram determined by the silvering method and 15,000 sq. cm. per gram determined by the water permeability method agree well with published results on similar pulps. It may thus be safely assumed as a basis for discussion that the actual external surface of the fibers employed is somewhere around the range given by the two above figures.

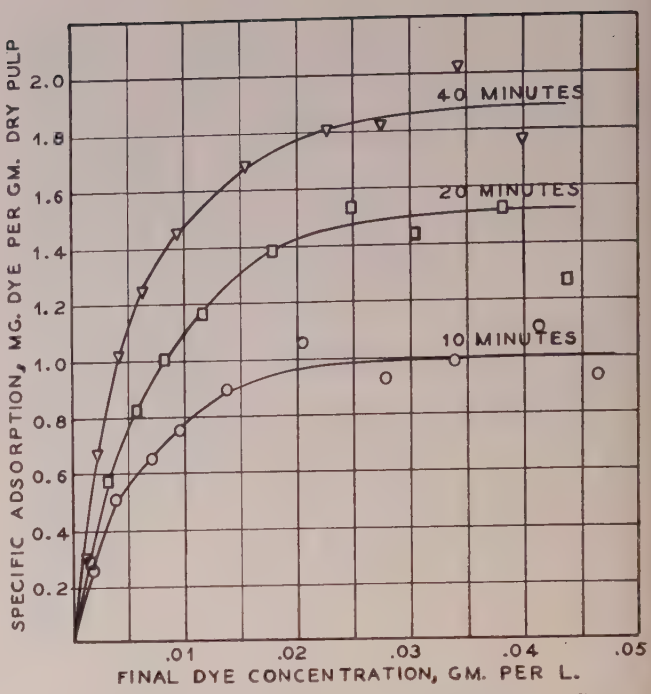


Fig. 4. Adsorption isotherms (25°C.) of Benzo Fast Scarlet on unbeaten sulphite pulp for various dyeing times. (KCl concentration, 1.25×10^{-3} M)

In connection with the earlier statements regarding the possible difference between apparent adsorption and actual adsorption and the probability of having solvent molecules in the adsorbed monolayer, the following evidence might be cited in support of the idea that the dye molecules will largely displace the water molecules from the cellulose surface: (1) the affinity of direct dyes for cellulose in the presence of electrolytes, (2) the relatively low solubility of the dye in water (approximately 0.02 mole per liter), (3) the large size of the dye molecules, and (4) the large number of polar groups on cellulose. It follows also that the reasonable agreement of the values of the external surface obtained by dye adsorption with those obtained by the silvering method and water permeability method leads to the belief that a large percentage of the surface of the cellulose must have been covered by dye molecules.

The horizontal portion (or nearly horizontal portion) of a Langmuir-type isotherm is taken to represent the saturation value for surface adsorption. In a discussion of modern views on substantivity of cotton dyes Rummler (*13*) has suggested that the effect of electrolytes in direct dyeing of cellulose may be to reduce the high electrokinetic potential and permit the approach of the dye anions. If it is assumed that electrolyte is necessary for the adsorption of dye on the fiber, then

in the presence of inadequate electrolyte, *saturation*—as far as this particular system is concerned—of the surface with solute may take place without the surface being completely *covered* with solute molecules. The more electrolyte present, the greater the area covered at saturation, until an optimum value is reached at which the surface is as completely covered as possible.

If this were the only phenomenon involved in the electrolyte-fiber-dye system, then addition of excess electrolyte beyond this optimum would have no effect on equilibrium adsorption. There are other phenomena involved, however. It has been assumed in this paper that the molecules of dye are adsorbed flat, as single molecules. This is probably what does occur at low dye concentrations and at low electrolyte concentrations. At higher concentrations, however, the possibility of adsorption on edge and adsorption as micelles should not be ruled out. As a matter of fact, some such phenomenon must occur if the high adsorptions observed in such cases are to be explained.

The matter of time of dyeing is another in which apparent area can be varied by changes in a variable unconnected with fiber surface. If the generally accepted molecular, micellar, and submicroscopic structure of cellulose as well as the well-known microstructure of cellulose fibers from wood are considered, the reason for an increase in apparent area with increase in the time of dyeing is obvious.

It should be accepted without contention that adsorption on the exposed, external surfaces of the fibers will take place extremely rapidly as contrasted with adsorption on the walls of submicroscopic crevasses and channels in the fiber. It would seem that dye would reach the available areas at the depths of such crevasses, beyond the motion of swirling liquid, rather slowly since a diffusion of large molecules is involved.

A qualitative expression of the dyeing from dilute solution encountered here might be as follows: in the first few minutes of dyeing, the gross external surface including fibrils and gentle surface undulations, being most accessible, takes up most of the dye that will eventually cover the surface; in a second period of time the penetration of the dye into the large crevasses is accomplished and the slow process of diffusion into the intermicellar spaces begins; in a third period, further take-up is primarily that of penetration into the fiber.

With the most careful technique, 10 min. dyeing time is the shortest in which reproducible results can be obtained. It is therefore assumed that 10 min. marks the limit of the first phase, adsorption on the gross external surface and on the fibrils and other projections. Whether or not 10-min. dyeing time is a desirable limit for adsorption experiments designed to yield "specific external surface" data is a matter to be decided when more information is available. For the present this minimum time for reproducible results is being employed, with good comparative results.

LITERATURE CITED

1. Heuser, E., "Cellulose Chemistry," page 114, New York, John Wiley & Sons, Inc., 1944.
2. Clark, J. d'A., *Paper Trade J.* 115, No. 1: 32–39 (July 2, 1942).
3. Browning, B. L., *Tappi* 33, No. 8: 410–412 (1950).
4. Browning, B. L., and Baker, P. S., *Tappi* 33, No. 2: 99–100 (1950).
5. Robertson, A. A., and Mason, S. G., *Pulp and Paper Mag. Canada* 50, No. 13: 103–110 (Dec., 1949).
6. Heustis, C. S., Thesis, University of Maine (1929).
7. Hess, K., and Gramberg, W., *Kolloid-Z.* 97: 87–96 (1941).
8. Stamm, A. J., and Millett, M. A., *J. Phys. Chem.* 45: 43 (1941).
9. Pauling, L., "The Nature of the Chemical Bond," 2nd ed., pages 164, 173, Ithaca, N. Y., Cornell University Press, 1945.
10. Morton, T. H., *J. Soc. Dyers Colourists* 62: 272–280 (1946); *C. A.* 41: 287 (1947).
11. Brunauer, S., "The Adsorption of Gases and Vapors," page 279, Princeton, Princeton University Press, 1945.
12. Beamesderfer, J. W., Thesis, University of Michigan (1947).
13. Rummler, H., *Spinner u. Weber* 55, No. 48: 6 (1937); *C. A.* 32: 101 (1938).

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Dye Adsorption on Wood Pulp

II. Relation of Dye Adsorption to Physical Properties of Beaten Sulphite Pulp

E. F. THODE, J. W. BEAMESDERFER, and A. J. CHASE

The application of a technique of adsorption of direct dye from dilute solution to the evaluation of properties of beaten pulp fibers is described. Correlation of the specific adsorption of dye, in milligrams of dye per gram of dry pulp, with beating time and with the physical properties of handsheets is reported. The relationship of this specific dye adsorption to the external specific surface as determined by the silvering technique and the permeability technique is also reported and discussed. It is concluded that the specific adsorption of direct dye under the experimental conditions employed is directly related to the external surface of pulp fibers. The specific adsorption of dye in the absence of electrolyte, which has also been studied, is shown to increase with beating at a rate materially different from that found in the presence of electrolyte.

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Further investigation into the fundamental significance of this phenomenon is thought desirable.

In the first paper in this series, a brief general introduction to the topic of determination of external specific surface was presented. It was stated that the ultimate aim of the entire investigation is the development of a technique of evaluating external specific surface of fibers by means of dye adsorption methods. The first paper described some characteristics of a direct dye used and presented experimental information on the adsorption of the dye on unbeaten fibers from bleached sulphite pulp. With such basic information at hand it became desirable to discover if dye adsorption could be related to the development of surface area known to occur in beating. That subject is the concern of this paper.

Papermakers have long been concerned with methods of control of the mechanical pretreatment of fibers which would enable prediction of ultimate physical properties of paper. The freeness test was developed for this purpose and has been correlated with properties of paper. It suffers the limitation, however, of not directly measuring any fundamental property of the fibers.

The area of the fibers in actual contact in a sheet of paper (the bonded area) is one such fundamental property that it would be desirable to evaluate in advance. As demonstrated by Forman (*4*), the strength development of pulp on beating can be conveniently related to this bonded area. At present, unfortunately, bonded area may be determined only by making a sheet of paper. At this juncture, one may yet say: "The only way to find out what kind of paper a pulp will make is to make a sheet of paper from it."

Fortunately, Forman's review indicates that a knowledge of the total external area, the external specific surface, may be as useful in predicting paper properties as knowledge of the bonded area. This external area may be determined by the silvering method or by the permeability method on unbeaten and beaten fibers. Both of these methods, while giving good comparative results, involve rather tedious procedures. Neither would be ordinarily suited for a mill control test if any operating change would be dictated by the results of the test. A control test, to be of value to operating personnel, must be accomplished in a matter of minutes, not hours. The results of a complete dye adsorption test may be available 15 to 30 min. after sampling as contrasted with 2 to 4 hr. for the methods previously mentioned. If more information on the relation of surface area to paper properties is to be forthcoming, and if the dye adsorption method can give a good indication of that area, then such method may be of great utility as well as of theoretical interest.

SILVERING METHOD

The original Clark-McEwen silvering method (*3*, *14*) has been modified by Browning and Baker (*1*, *2*) to be now applicable with accuracy and reproducibility to beaten as well as unbeaten pulps. Briefly, this method consists of coating the fibers from a sample of pulp with a layer of deposited silver and then utilizing the catalytic reactivity of the silvered surface to decompose hydrogen peroxide solution. The amount of peroxide decomposed in a stated length of time is determined by titration of the residual peroxide with potassium permanganate solution. From the number of milliliters of permanganate used (appropriately standardized) the surface area of the fiber sample may be determined from the calibration curve prepared by McEwen (TAPPI method T 226 sm-46) (*14*) Modifications incorporated in the above-mentioned TAPPI method by Browning (*1*) consist largely of scrupulous filtering operations to prevent the loss of fines. The silvering step itself must be carried out at 100°C. After silvering there is some tendency for fibrillated portions of fibers to break off, so much care must be exercised to prevent loss of such material.

For a given sample and type of pulp, such factors as consistency, total size of sample, and time of silvering must be empirically adjusted. The calibration curve as used in connection with a determination of consistency yields data as surface area in square centimeters per gram. This area so obtained is only as good as the calibration method, which involved silvering of sheets of cellophane of known area. While there is little question that the "areas" obtained by silvering are of the correct order of magnitude, it is a matter of question whether the external area, whatever that may be, has been absolutely determined by this method.

Before leaving the topic of the silvering method, it is not amiss to comment that extreme refinement of technique is required in every step and operation of the procedure. In order to obtain consistent and reproducible results, minute attention to such details as speed of stirring during silvering and peroxide decomposition, technique of filtering, and others mentioned above, is essentially necessary.

PERMEABILITY TECHNIQUE

Recent publications by Mason (*7*, *8*) and Robertson and Mason (*10*) have brought attention to the fact that the flow of a fluid through the capillaries of a fiber pad may be related to the surface areas of the capillaries. As employed by Mason, et al., the Kozeny-Carman equation

$$(Kc^2)^{1/3} = \frac{1}{(k\sigma^2)^{1/3}} - \frac{\alpha c}{(k\sigma^2)^{1/3}}$$

yields the surface area σ and the apparent specific volume of the pulp α from determinations of the permeability coefficient K at various values of c, the concentration of fibers in the pad. k is a shape-orientation factor determined to have a value of 5.55 for wood pulp fibers.

The permeability coefficient is related to the rate of flow, the pressure causing flow, the viscosity of the permeant fluid and the dimensions of the pad by the equation.

$$K = \frac{Q\mu L}{A\Delta P}$$

where

Q = rate of flow of permeant
μ = viscosity of permeant
L = pad thickness
A = pad area
ΔP = pressure drop

all in consistent units. If the temperature is steady

and the head causing flow remains the same, all factors included in K are constant except the rate of flow and the pad thickness. In making a determination, pad thickness is controlled at will and the corresponding flow rate determined. If the pad is subsequently weighed and dried, fiber concentration for a given thickness may readily be computed. The other figures

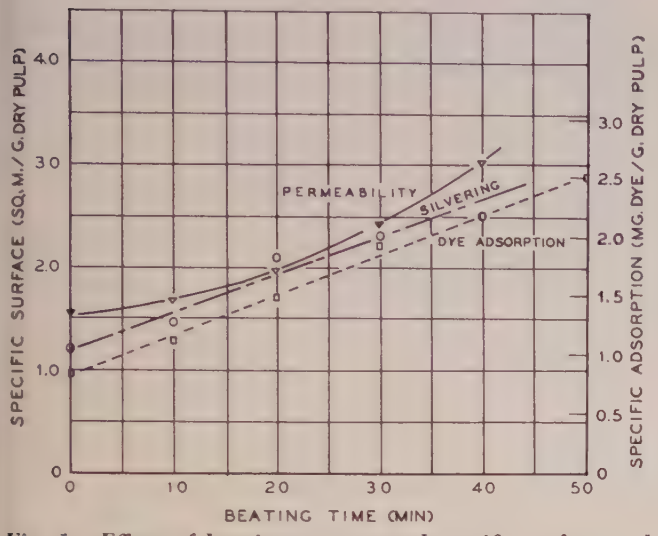


Fig. 1. Effect of beating on external specific surface and on specific dye adsorption of bleached sulphite pulp

for the Kozeny equation are computed as indicated and a plot is made of experimental values of $(Kc^2)^{1/}$ as ordinate versus values of c as abscissas. The ordinate intercept is equal to $1/(k\sigma^2)^{1/3}$ from which the value of the surface area σ is readily computed.

Although great care must be exercised in pad formation, this method readily yields good reproducible results with a little practice. The observations and computations are rather long, however, and the method becomes virtually impossible of application with highly beaten pulps because of the high resistance to flow offered by such beaten stock.

It is apparent that the area determined by the permeability method is the so-called "hydrodynamic" surface of the fibers in the pad. Not only the actual surface of the fibers themselves but any immobile layer of adsorbed water would be involved here. How this surface is related to that determined by the silvering technique has not yet been fully explained.

DYE ADSORPTION TECHNIQUE

Application of the dye adsorption technique is predicated on the idea that if pulp fibers are dyed for but a short time in a very dilute dyebath only the external surface of the fibers will adsorb dye. This is discussed in detail in the previous paper (q.v.). The procedure followed in obtaining the data reported herein is summarized below:

Reagents required are a stock solution of Benzo Fast Scarlet dye of about 0.16 gram per liter concentration (0.159 gram per liter used here) and a standard solution of potassium chloride of any convenient concentration (0.133 M used).

The pulp to be studied, if dry, must be soaked in distilled water for at least 24 hr. prior to use. It is subsequently thoroughly defibered by 2-min. treatment in a Waring Blendor at about 1% consistency. These steps are unnecessary for wet pulp taken from the beater.

WASHING OF SAMPLE

Although the washing operation on unbeaten pulp may be essentially a washing by decantation, this is not possible with beaten pulp because of danger of loss of fines. All samples taken from the beater are washed free of electrolyte by pouring them into a large Buchner funnel in which is placed a single layer of medium porosity filter paper. Water is withdrawn until the stock is at about 8% consistency, then the funnel is refilled with distilled water, the stock gently stirred with a glass rod, and the water withdrawn again. This process should be repeated six times. After the last washing, vacuum is applied until the consistency reaches about 33%. The pad of pulp so formed is then peeled off the filter paper into the beaker used for dyeing.

ADSORPTION PROCEDURE

During the remainder of the procedure a temperature of 25°C. should be maintained as closely as possible. A sample of about 2 grams (air-dry weight) of pulp is employed. After the washing operation, this pulp is dispersed in sufficient distilled water so that the final volume of the dyebath (including the dye solution

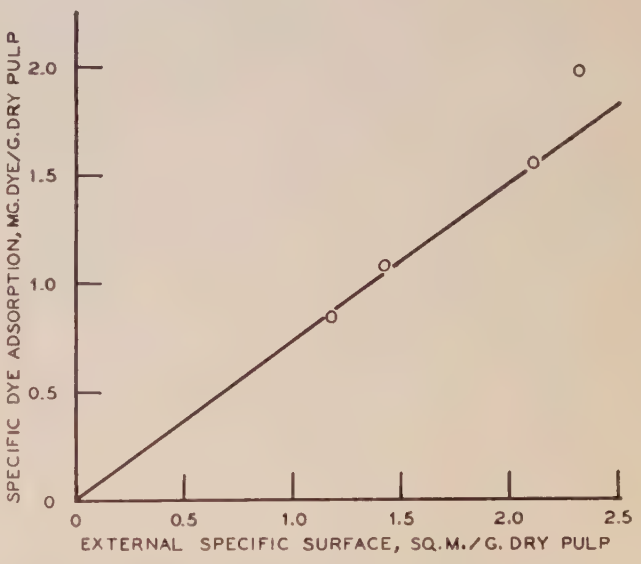


Fig. 2. Relation of specific dye adsorption to external specific surface as determined by the silvering method

and the potassium chloride solution added subsequently) will be exactly 400 ml. Potassium chloride solution is added in an amount which will give a final concentration of $M/1000$ (3 ml. of 0.133 M solution) and gentle stirring with an electric stirrer is begun. One hundred milliliters of the dye solution are then pipetted into the pulp suspension; the time clock is started at the instant the dye first enters the mixture. Stirring is continued for 9 min., after which a sample of the mixture is poured

into each of two centrifuge tubes and centrifuged for about 30 sec. at approximately 3300 r.p.m. By this procedure total dyeing time of 10 min. is employed. Final dye concentration in the supernatant liquor is determined spectrophotometrically as described in the previous paper (q.v.). With sulphite pulp beaten more than 20 min. it is necessary to apply a turbidity correction to the spectrophotometric observations. This may be done by the method of Harrison (*5*). By this method, a constant correction factor of 1.13 was obtained.

Determinations of dye adsorption in the absence of electrolyte are made exactly as above except that potassium chloride solution is not added.

Adsorption results are customarily reported as as grams of adsorbate x taken up by the grams of adsorbent employed m. In this paper, specific dye adsorption x/m is reported as milligrams of dye per gram air-dry pulp.

RESULTS

Beater tests on bleached spruce sulphite pulp were conducted according to TAPPI Standard T 200 m-45 (*13*) and the samples withdrawn from the beater used for determinations of specific surface by the silvering

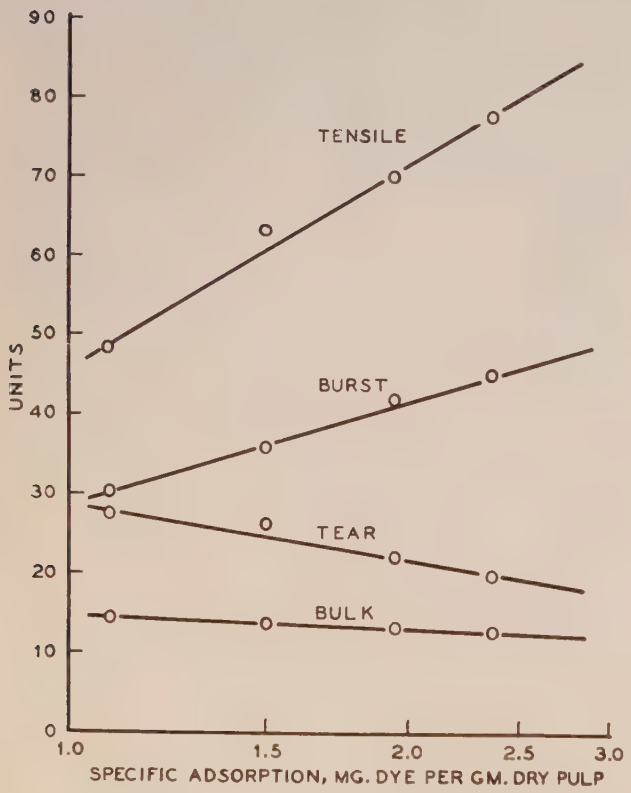


Fig. 3 Correlation of physical properties of pulp handsheets with specific dye adsorption

and by the permeability techniques, also for dye adsorption experiments. The increase of external surface by silvering and by permeability and the increase of specific dye adsorption as beating progresses are contrasted in Fig. 1. In Fig. 2, specific dye adsorption is plotted as a function of external specific surface (as obtained by the silvering technique).

Other beater tests were made in which handsheets were made and tested according to TAPPI Standard T 220 m-46 (*14*), while samples of the same stock were used for dye adsorption tests. Figure 3 shows the relationship between physical properties of the handsheets and dye adsorption (in the presence of KCl), while Fig. 4 shows the same relationship for dye adsorp-

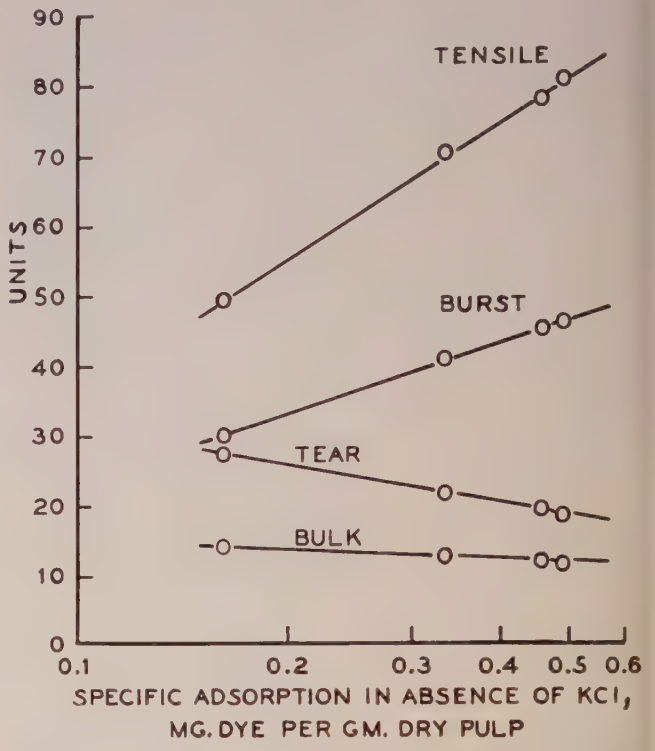


Fig. 4. Relation of handsheet properties to specific dye adsorption results obtained in the absence of electrolyte

tion conducted in the absence of electrolyte. The semilogarithmic method of plotting is that recommended by Forman (*4*) for the correlation of beater test data. A plot of physical properties as a function of beating time for the same stock is shown, for comparison, in Fig. 5.

DISCUSSION

From an examination of Fig. 2, it may be observed that specific dye adsorption appears to be a linear function of external surface area as determined by the silvering method. All the data reported in this paper are for pulp from the same roll of mill stock. All stock for beater tests was put through a standard beater cycle, employing the same laboratory beater on every occasion. However, the dye adsorption data presented in Figs. 1 and 2 are from different beater tests than those from which the silvering and permeability data are drawn. Considering the possibility of accidental variation from one beater test to another, the fact that three of the points lie on a straight line through the origin is taken as an encouraging indication that specific dye adsorption does directly parallel surface area development.

The displacement of the last point in Fig. 2 is more likely horizontal than vertical. As may be seen from Fig. 1, the rate of increase of surface area by silvering

appeared to drop off after 30-min. beating time, while no such nonlinearity appeared in the dye adsorption data. In spite of the employment of the latest refinements recommended by Browning (*1*) the workers in the present investigation encountered extreme difficulty in obtaining reasonable and consistent results by the silvering technique for pulp beaten 30 min. or more.

In connection with Fig. 1, it should be noted that the rate of increase of external surface by the permeability method rises with increasing beating time; this is in agreement with the findings reported by Robertson and Mason (*10*). The curve shown here is somewhat flatter than that reported for sulphite pulp in Mason's work, but the variance may well be ascribed to differences in the condition of the beater tackle as well as to possible differences in the species of wood represented in the pulp.

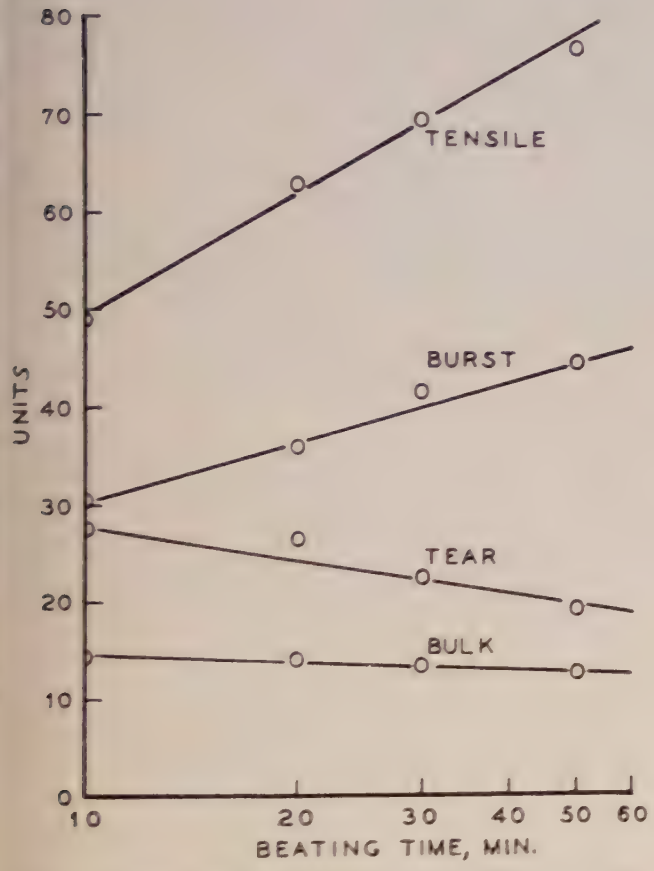


Fig. 5. Conventional correlation of handsheet properties with beating time

Forman (*4*) has reported that careful observations of the development of external surface area, as determined by the silvering technique, demonstrate essential linearity of external surface with beating time. The data of Fig. 1 demonstrate linearity of dye adsorption with beating time. From this information, as well as from the experimental data presented in Fig. 2, it may be concluded that the value for the specific dye adsorption obtained by the technique herein described is directly related to the external surface area of pulp fibers. This conclusion is necessarily predicated on the assumption that the improved silvering technique measures the external surface of fibers or something directly related to that property. It necessarily follows, also, that *if* the dye adsorption and silvering techniques do measure the external surface area of fibers, or some property directly related thereto, the permeability technique does not measure the *same* property. In the absence of a satisfactory definition of the property to be measured (external surface), however, the question of the relative validity of the three methods must remain open.

Further indications of the relation of specific dye adsorption to the properties of pulp are shown in Figs. 3 and 4. Reference is made again to the report by Forman (*4*) who showed that the various physical properties of pulp handsheets are, within limits, linearly related to the logarithm of surface area, also to the logarithm of bonded area. In Fig. 3, the results of a typical beater test are plotted semilogarithmically against dye adsorption values obtained by the usual technique. These data serve to confirm the conclusions drawn from Figs. 1 and 2.

Figure 4 presents a novel and interesting aspect of the situation. Here, dye adsorption was carried out in the absence of electrolyte on the various samples of beaten pulp and the logarithm of the results plotted against physical properties. Specific adsorption under these conditions is only about one-fifteenth that observed by the standard technique for unbeaten pulp, but, after the first 10 min. of beating, appears to increase linearly with beating time. The physical properties of the pulp handsheets, therefore, correlate well with this function.

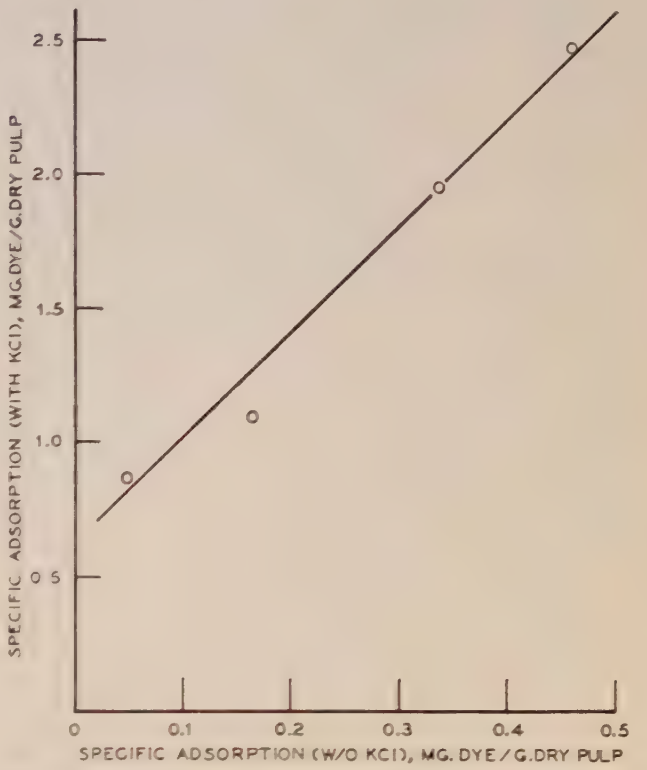


Fig. 6. Relationship of dye adsorption in presence of electrolyte to dye adsorption in absence of electrolyte

Speculation immediately arises as to what funda-

mental significance, if any, may be attached to dye adsorption data obtained in the absence of electrolyte.

Effect of Electrolyte on Dye Adsorption

Peters and Vickerstaff (*9*) have presented a comprehensive survey of theories regarding the adsorption of direct dye in the absence of foreign electrolytes. Citing the work of themselves and others they conclude that direct dye ions of high charge and low affinity for fiber may not be adsorbed at all on cellulose in the complete absence of foreign electrolytes, but that appreciable dyeing may take place in the case of dibasic (low charge) dyes of high affinity. This is because, on the one hand, the supposedly high negative electrokinetic potential on cellulose in the absence of electrolyte is presumed to prevent the approach of polybasic ions. On the other hand, in the case of dyes that are dibasic, it is thought that the "active centers" on the surfaces of the cellulose fibers have fields of force sufficiently strong to overcome the mutual repulsions of the electrokinetic potentials. Differing results obtained when using viscose rayon, ramie fiber, and cotton are attributed to structural differences of the arrangements of cellulose chains and consequent differences in the number and character of "active centers" among the various sources of fiber.

The dye used in this investigation was dibasic and presumably one having high affinity for the fibers. Adsorption on "active centers" was to be expected. If the surfaces of wood pulp fibers exposed on beating are the same as those presented by fibers which have not been subject to mechanical treatment, then the proportional rate of increase of specific dye adsorption in the *absence* of electrolyte should be equivalent to the rate of increase of dye adsorption in the *presence* of a standard amount of electrolyte. As demonstrated by Fig. 6, this is not the case. A beating time which approximately doubles the specific dye adsorption in the presence of electrolyte yields better than a fivefold increase in specific dye adsorption in the absence of electrolyte. It certainly does not appear that *all* the new surface has a higher affinity for dye than the original surface, but it does appear that there is a much higher *proportion* of "active areas" in the new surfaces than in the original.

This conclusion that the fresh surface created by beating differs in some way from the original surface is not novel. Credit for first demonstrating this effect with dyestuffs apparently should go to Simons (*11*), who recently developed a two-stain technique for the microscopic evaluation of effects of mechanical action on fibers. Although the conditions of dyeing employed by Simons differed widely from those of the present work, one conclusion may be drawn in common: the new surface exposed by beating has a different affinity for direct dye than does the original surface.

Speculation as to the underlying cause of these differences in dye adsorption could run on to great lengths to no profitable end. It may be of interest to cite three points, which may be taken to be facts, drawn from the papers (*4*, *12*) and discussion at the Quebec Fundamental Research Conference:

1. Beating increases the amount of hemicelluloses on the exposed surfaces; moreover, there are strong indications that there is a membrane associated with the secondary fiber wall which is predominantly mannan, instead of cellulose. According to Lewis (*6*), this may be the true cambial wall.
2. Beating produces only a very small increase in the total sorptive surface for water vapor, which is taken to be a measure of crystallinity. It is thought from the data available that most, if not all, of this change (decrease in crystallinity) is at the external surface.
3. The bonded area in paper is virtually nil for unbeaten pulp but increases steadily with beating at such a rate that practically all of the increase in external surface area over that found in the unbeaten pulp may go into the bonded area.

From these points it may be speculated that dye adsorption in the absence of electrolyte has one of the following characteristics: (1) it may be a measure of the hemicellulose available for bonding; (2) there may be some connection between dye adsorption and relative crystallinity of the surface; or (3) this determination, for reasons unknown, may serve as a useful tool in the prediction of bonded area.

CONCLUSIONS

It has been experimentally demonstrated that the specific adsorption of a direct dye from dilute solution according to a standardized technique herein described is directly related to the specific external surface of sulphite pulp. It has been similarly demonstrated that this specific dye adsorption is related to the physical properties of handsheets made from sulphite pulp beaten for 10 to 50 min.

The specific adsorption of dye in the absence of electrolyte has been shown to increase with beating at a rate materially different from that found in the presence of electrolyte. It is thought that further investigations may show a relationship between this phenomenon and one of the fundamental physical or chemical properties of fiber surfaces.

LITERATURE CITED

1. Browning, B. L., *Tappi* 33: 410–412 (1950).
2. Browning, B. L., and Baker, P. S., *Tappi* 33: 99–100 (1950).
3. Clark, J. d'A., *Paper Trade J.* 115, No. 1: 32–39 (July 2, 1942); *Tech. Assoc. Papers* 25: 568–575 (1942).
4. Forman, L. V., *Tappi* 33: 444–450 (1950).
5. Harrison, W. D., *Tech. Assoc. Papers* 20: 314–320 (1937).
6. Lewis, H. F., *Tappi* 33: 418–424 (1950).
7. Mason, S. G., *Pulp and Paper Mag. Canada* 48, No. 10: 76ff (1947).
8. Mason, S. G., *Tappi* 33: 403–409 (1950).
9. Peters, R. H., and Vickerstaff, T., *Proc. Royal Society* A192: 292–308 (1948).
10. Robertson, A. A., and Mason, S. G., *Pulp and Paper Mag. Canada* 50, No. 13: 103–110 (Dec., 1949).
11. Simons, F. L., *Tappi* 33: 312–314 (1950).
12. Stamm, A. J., *Tappi* 33: 435–439 (1950).
13. Technical Assn. of the Pulp and Paper Industry, "TAPPI Standards" (1945).
14. Technical Assn. of the Pulp and Paper Industry, "TAPPI Standards" (1946).

Received Jan. 18, 1952. Presented at the 37th Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 18–21, 1952.

Drawn in part from a thesis presented by Andrew J. Chase to the Graduate Faculty of the University of Maine in partial fulfillment of the requirements for the degree of Master of Science in Chemical Engineering, Feb., 1951. Paper No. 69 in the Maine Technology Experiment Station series.

This investigation was carried out in the facilities of the Department of Chemical Engineering at the University of Maine with the cooperation of the Department of Chemistry. Grateful acknowledgment is made of the helpful criticisms and comments of many colleagues at our own and other institutions. Among these are I. B. Douglass, L. C. Jenness, C. G. Landes, H. F. Lewis, S. G. Mason, D. G. Salley, and F. A. Soderberg. The helpfulness of the General Dyestuff Corp. in supplying the special unloaded dye used and of the Penobscot Chemical Fibre Co. in furnishing the pulp is much appreciated. The Maine Agricultural Experiment Station cooperated by furnishing the spectrophotometer needed for these experiments. Further work on this topic is now being prosecuted in cooperation with the TAPPI Fundamental Research Committee as part of TAPPI Project 31 at the University of Maine.

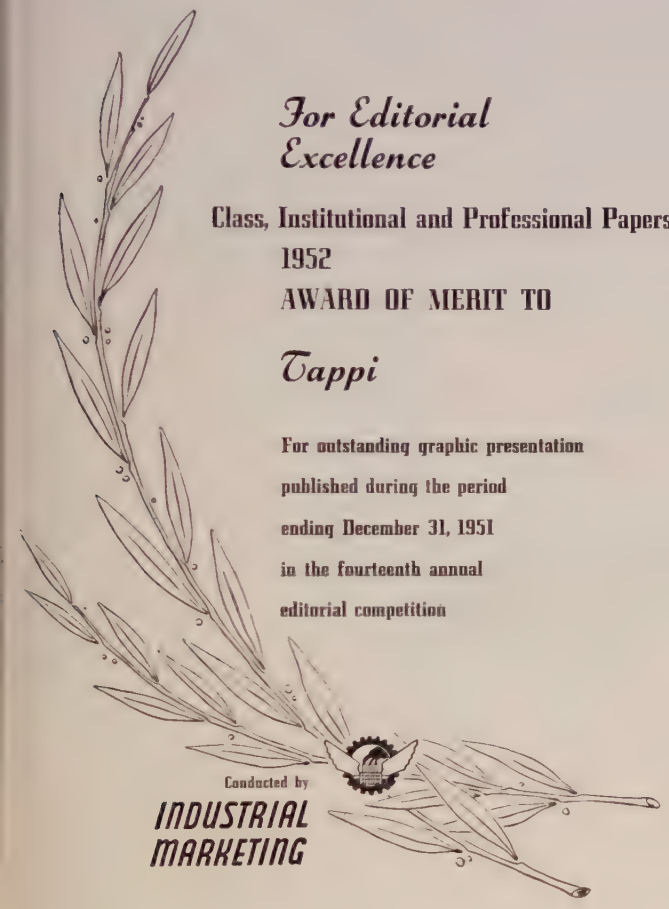
ASSOCIATION NEWS AND EVENTS

Editorial Achievement

The Editor of *Tappi* has received the following letter from Merle Kingman, Managing Editor of *Industrial Marketing.*

Dear Mr. Macdonald:

"Congratulations! You have won an award in *Industrial Marketing*'s 14th Editorial Achievement Competition. A



certificate of merit was awarded for the graphic presentation and format of your technical section in *Tappi.*

"Thank you for your participation and interest, and congratulations, again, on winning high honors."

Engineering Conference

The Seventh Engineering Conference of the Pulp and Paper Industry will be held at the Morrison Hotel, Chicago, Ill., on Oct. 13–16, 1952.

The program for this conference appeared in the July issue of *Tappi.*

In the Mill Design and Economic Aspects Session, the paper "Paper Mill and Machine Reconstruction in Europe since the War" has been withdrawn.

In the Materials Handling Session the following paper has been added: "Wastepaper Handling," by William Edwards, Pulp and Paper Board Div., National Production Administration, Washington, D. C.

In the Electrical Engineering Session the report "Power Requirements for Press Sections" has been withdrawn.

In the Drying and Ventilating Session the following paper has been added: "Follow the Rules for Proper Steam Blast Coil Installation and Avoid Costly Trouble," by R. G. Lubinsky, the Tram Co., La Crosse, Wis.

The Get-Together Party and Dinner scheduled to be held on Tuesday evening, October 14, will be sponsored by vendor companies serving the pulp and paper industry. Companies having offices in or near Chicago have been solicited for funds to finance this event. Any company that has not been solicited is welcome to participate. Contributions should be sent to the Seventh Engineering Conference of TAPPI, Room 2330, 105 W. Adams St., Chicago 3, Ill.

On Thursday, October 16, there will be official plant visits to the Crane Co. and Link-Belt Co. in Chicago. Noncitizens of the United States are required to apply to the management of these companies for permission to take these plant tours at least one month before the meeting. Applications should be sent to W. R. McNally, Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., and Joseph E. Bradbury, Crane Co., 836 S. Michigan Ave., Chicago 5, Ill. These applications should be forwarded as soon as possible to avoid disappointment at the time of the plant visits.

Testing Conference

The TAPPI Testing Conference will be held at the College of Forestry, State University of New York, Syracuse, N. Y., on Sept. 10–12, 1952. This meeting which is open to all TAPPI members will be devoted to the consideration of new and revised testing procedures. Following is the schedule of sessions.

Sept. 10, 1952

Morning	*Afternoon*
Paper Testing	Paper Testing
Nonfibrous Materials Testing	Nonfibrous Materials Testing
Chemical Methods	Chemical Methods
Microscopy	Microscopy
Wax Testing	Wax Testing

Sept. 11, 1952

Morning	*Afternoon*
Paper Testing	Pulp Testing
Nonfibrous Materials Testing	Nonfibrous Materials Testing
Chemical Methods	Microscopy
Packaging Materials Testing	Packaging Materials Testing
Wax Testing	Wax Testing

Sept. 12, 1952

Morning	*Afternoon*
Optical Properties	Optical Properties
Nonfibrous Materials Testing	Pulp Testing
Packaging Materials Testing	Wax Testing
Pulp Testing	
Wax Testing	

Some of the methods to be considered include the following:

Methods of Calibrating Fading Lamps
Determining the Brightness of Clays
Study of Glossmeters
Water Vapor Permeability at Zero
Flavor and Odor Transfer
Water Vapor Permeabilities of Packages
Water Vapor Permeability at 100°F. and 90% R. H.

Insect Resistance
Measurement of Pin Holes in Paper
Blood Resistance of Butchers' Wrapping Paper
Flexural Resistance and Deflection of Fiberboard
Analysis of Clay, Casein, Enzymes, and Rosin Size
Chain Length Distribution Method
Formaldehyde Content of Paper and Pulp
Grit in Paper
Rubber in Paper
Chlorine Consumption
Potassium Permanganate Number
Rosin in Paper
Review of Pulp Testing Methods

Testing instrument companies who may wish to exhibit new and recently improved machines may do so. Arrangements for receiving the machines should be made with Robert Hitchings, College of Forestry, State University of New York, Syracuse, N. Y. All costs involved in transporting and handling such machines are to be borne by the exhibitor.

Room reservations should be made at the Syracuse Hotel, Syracuse, N. Y., right away.

Plastics Conference

The TAPPI Plastics Conference will be held at the College of Forestry, State University of New York, Syracuse, N. Y., on Nov. 5–6, 1952.

Room reservations should be made immediately at the Syracuse Hotel, Syracuse, N. Y.

Alkaline Pulping Conference

The Alkaline Pulping Conference will be held at the Battle House, Mobile, Ala., on Nov. 12–14, 1952.

The program is expected to cover a number of the following subjects:

1. Recovery of Sulphur by Black Liquor Oxidation
2. Recovery of Sulphur from Stack Gases
3. Addition of Sulphur for Sulphidity Control
4. Importance of Sulphidity
5. Sulphidity Make-up by Use of Spent Semichemical Liquor
6. Reduction of Soda Losses and the Recovery Operation
7. New Developments in Recovery Furnace Design
8. Use of Fiber Gases for Black Liquor Evaporation
9. Recovery Furnace Operation
10. Instrumentation of Recovery Furnaces
11. Recovery Operation Corrosion Problems
12. Masking Sulphate Mill Odor
13. Stacks for Odor Dispersion
14. Elimination of Mill Odors with Chlorine Compounds
15. Scrubbing for Odor Elimination
16. Turbulent Suspension Burning of Wood Refuse
17. Kraft Mill Effluents

British Technical Meeting

The 64th General Conference of the Technical Section of the British Paper and Board Makers' Assn. will be held at the Midland Hotel, Manchester, England, on Oct. 22, 1952. H. W. Giertz of the Swedish Forest Products Research Institute, Stockholm, Sweden, will present a paper on "Cellulose Chemistry and Fiber Structure." Members of TAPPI who may be traveling in Europe at the time are welcome to attend.

Semichemical Pulping Committee

John N. McGovern, Chairman of the new TAPPI Semichemical Pulping Committee, has announced the membership of this committee as follows:

J. N. McGovern, *Chairman*, Forest Products Laboratory, Madison 5, Wis.
C. W. Converse, Secretary, Sprout, Waldron & Co., Muncy, Pa.
R. W. Brown, Hammermill Paper Co., Erie, Pa.
R. G. Coker, Sonoco Products Co., Hartsville, S. C.
J. S. Hart, Pulp and Paper Research Institute of Canada, Montreal 2, Canada
Gerald Haywood, West Virginia Pulp and Paper Co., Luke, Md.
R. G. Knechtges, The American Pulp and Paper Co., Filer City, Mich.
H. J. Lausman, Consolidated Water Power and Paper Co. Wisconsin Rapids, Wis.
D. J. MacLaurin, Institute of Paper Chemistry, Appleton, Wis.
W. W. Marteny, National Container Corp., Tomahawk, Wis.
J. E. Sapp, Gaylord Container Corp., Bogalusa, La.
J. A. Staidl, Camp Manufacturing Co., Franklin, Va.
J. F. Stevenson, The Mead Corp., Chillicothe, Ohio
C. K. Textor, The Bauer Bros. Co., Springfield, Ohio
S. A. Woodruff, Battelle Memorial Institute, Columbus, Ohio

EQUIPMENT SURVEY SUBCOMMITTEE: J. E. Sapp, *Chairman*, R. G. Coker, D. J. MacLaurin, J. A. Staidl, and J. F. Stevenson

SEMICHEMICAL PULPING MEASURES SUBCOMMITTEE: R. W. Brown, *Chairman*, J. S. Hart, R. G. Knechtges, and H. J. Lausman

STANDARD TERMS SUBCOMMITTEE: C. K. Textor, *Chairman*, Gerald Haywood, and W. W. Marteny

BIBLIOGRAPHY AND REVIEW SUBCOMMITTEE: J. N. McGovern, *Chairman*, S. A. Woodruff

NEWS NOTE SUBCOMMITTEE: C. W. Converse, *Chairman*

RECENT BOOKS

Estimating Standards for Printers. By Fred W. Hoch, Fred W. Hoch Associates, Inc., New York. 1952. Cloth, 6 × 9, 278 pages. $5.25.

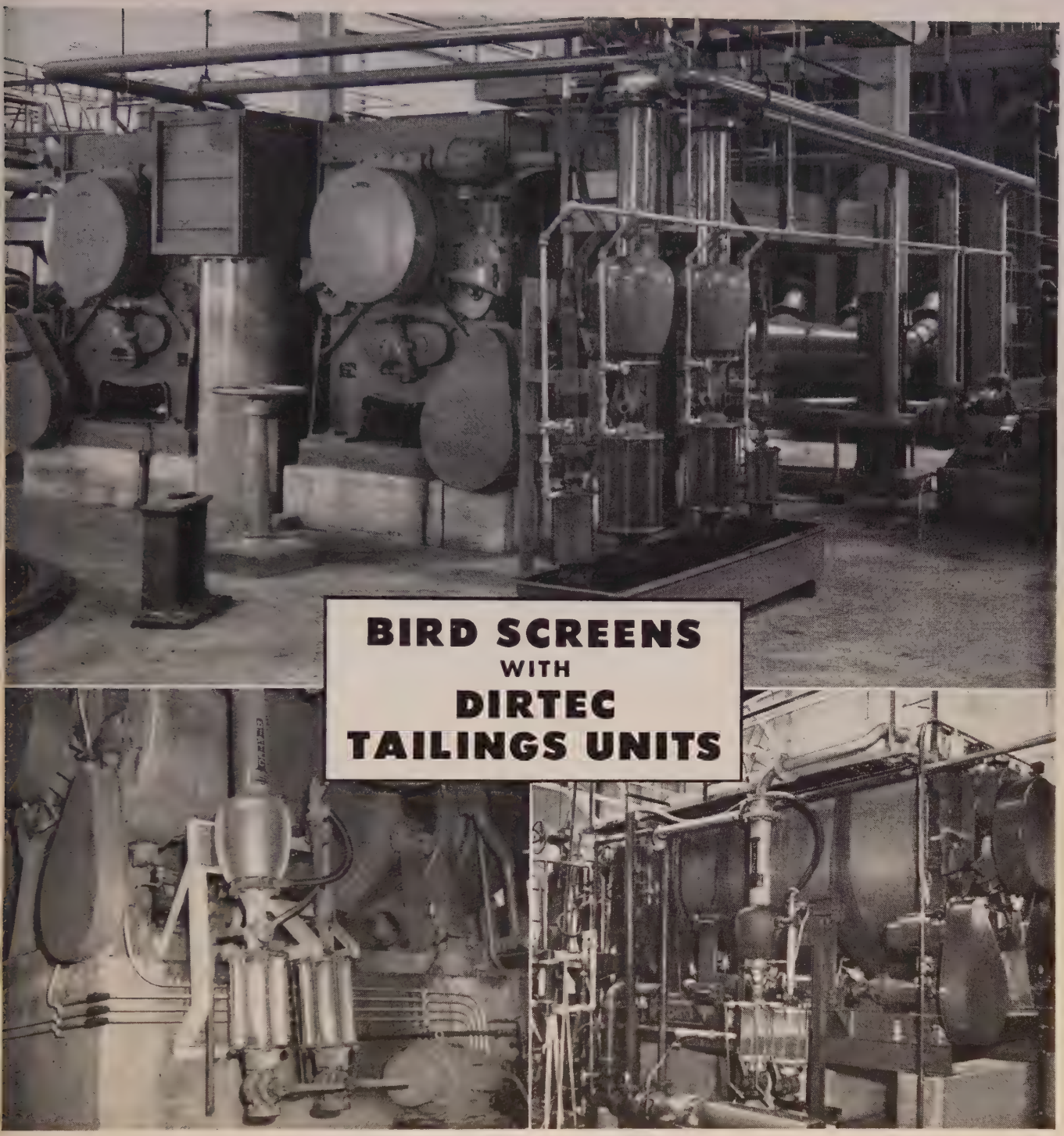
Fred Hoch is well known throughout the world of graphic arts. He has written many useful books for printers. In the book's foreward John J. Deviny, Public Printer of the United States states: "This is an unusual book. Most books represent the experience of an individual. This book is more than that. It comprises two generations of expert experience and judgment on the part of many men, because it has been built up through a continuity of forty of association work. It will probably never be duplicated by any other work on estimating."

Mr. Hoch's book is designed to give the industry, and the student of estimating and printing a comprehensive explanation of all of the operations entering the printed product. Among the subjects covered are: Paper, Composition, Imposition, Presswork, Make-ready, Press Running, Ink and Bronzing, Cutting, Folding, Stitching, Binding, Art Work and many miscellaneous details.

Handbook of Engineering Fundamentals. 2nd Ed. Edited by Ovid W. Eshback, Northwestern Technological Institute. New York, John Wiley & Sons. Fabricoid, $5^1/_2 \times 8^1/_2$, 1324 pages. $10.

Thirty-nine distinguished scientists contributed to this completely revised reference book. The 1st edition was published in 1936. The handbook differs from the standard engineering handbooks in that it covers a broader scope, including mechanical, electrical and structural engineering, together with details on chemistry, metallic and nonmetallic materials. Mathematics is covered in an excellent manner. Other subjects featured include flow of fluids, engineering thermodynamics. It is an excellent addition to any engineering library.

Note: Books reviewed in this section may be obtained from the Book Department of the Technical Association of the Pulp and Paper Industry, 122 East 42nd Street, New York 17, N. Y.



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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Alvina L. Ahl, Librarian, Kimberly-Clark Corp., Neenah, Wis.

Charles W. Atkinson, Technical Director, Canec Div., The Flintkote Co., Hilo, Hawaii, a 1928 graduate of Cornell University.

Eduardo Brustia, Mechanical Engineer, Cartiere di Verona, Milano, Italy, a 1951 graduate of Politecnico di Milano with an Eng.D. degree.

Grover J. Daly, Chief Packaging Engineer, Ottawa River Paper Co., Toledo, Ohio, a 1943 graduate of the University of Chicago.

Michael J. Dunford, Control Chemist, Coosa River Newsprint Co., Coosa Pines, Ala., a 1946 graduate of the University of Wisconsin.

Robert H. Farmer, Officer in Charge, Section of Wood Chemistry, Dept. of Scientific and Industrial Research, Forest Products Research Laboratory, Princes Risborough, Nr. Aylesbury, Bucks., England, a 1933 graduate of Oxford University with a D.Sc. degree from E.T.H. College, Zurich, in 1935.

John W. Fitzpatrick, Manager, Central Methods Dept., Marathon Corp., Menasha, Wis., a 1939 graduate of the University of Wisconsin.

Morimasa Hanaya, Engineer, Toyo Pulp Mfg. Co., Kure City, Japan, a 1932 graduate of Keto University.

Roy P. Hawley, Process Engineer, Douglas Aircraft Co., Inc., Santa Monica, Calif., a 1937 graduate of Iowa State College.

William J. Hoffmann, Manager, Ault-Wiborg Co., Manila, Philippines.

Yasuo Hosokawa, Toyo Ink Mfg. Co., Ltd., Tokyo, Japan, a 1927 graduate of Tokyo Technological College.

Hubert A. Idle, Director of Research, Ault & Wiborg Ltd., London, England. Attended the University of London.

Frank H. Jewett II, Technical Representative, Gallowhur Chemical Corp., New York, N. Y., a 1939 graduate of Bates College.

James M. Jopp, Chief Engineer, Brown Corp., LaTuque, P. Q., Canada, a 1925 graduate of the University of Wisconsin.

Norman F. Kennedy, Director of Research, Corn Industries Research Foundation, New York, N. Y., a 1917 graduate of Williams College.

John E. Killinger, Manager, Technical Sales Dept., Penick & Ford, Ltd., Inc., Cedar Rapids, Iowa, a 1927 graduate of Pennsylvania State College, with a Ph.D. degree from Iowa State College in 1930.

Emmanuel F. Koch, Salesman and Treasurer, Cyrus Wm. Rice & Co., Pittsburgh, Pa., a 1917 graduate of Carnegie Institute of Technology.

Ernst Kurschner, Manager, Niederrheinische Papier- un Pappenfabrik A.G., Neuss/Rheim, Germany, a graduate of Technische Hochschule, Darmstadt.

Howard J. Leech, Student, The Institute of Paper Chemistry, Appleton, Wis., a 1948 graduate of the University of Pennsylvania.

Adrian R. Leger, Assistant Sulphite Superintendent, Anglo-Newfoundland Development Co., Ltd., Grand Falls, Newfoundland, Canada, a 1946 graduate of Laval University.

Kurt Lenz, Production Manager, Pulp Mill, Rohtas Industries Ltd., Dalmianagar/Bihar, India, a 1931 graduate of the Engineering College, Loethen.

John A. Luke, Personnel Manager, West Virginia Pulp & Paper Co., Charleston, S. C., a 1949 graduate of Yale University.

Dimitri G. Manolis, Student, University of Maine, Orono, Me.

John Morris, Instrument Engineer, Union Bag & Paper Corp., Savannah, Ga., a 1949 graduate of Princeton University.

Cyrus N. Mull, Chief Engineer, the Mead Corp., Chillicothe, Ohio.

John Mumford, Technical Manager, Sidney Cooke Pty. Ltd., Melbourne, Australia, a 1946 graduate of Melbourne Technical College.

G. Brunner Muratti, Electrical Engineer, Cartiere di Verona, Milano, Italy, a 1951 graduate of Politecnico di Milano with an Eng.D. degree.

Toshihide Ozawa, Chief Engineer, Nanshin Pulp K.K., Nagano Pref., Japan, a 1944 graduate of Tokyo University.

Louis Raugh III, Chemist, Champion Paper & Fibre Co., Hamilton, Ohio, a 1950 graduate of Miami University, Oxford, Ohio.

Joseph L. Richardson, Resident Manager, Hudson Pulp & Paper Corp., Southern Div., Palatka, Fla.

Lucy K. Rumble, Librarian, Periodical Div., University of Illinois Library, Urbana, Ill.

Richard I. Rush, Professor and Head of Chemistry Dept., Centre College of Kentucky, Danville, Ky., a 1922 graduate of Johns Hopkins University with a Ph.D. degree in 1927.

James Sackellares, Shift Chemist, Southern Paperboard Corp., Port Wentworth, Ga., a 1948 graduate of Georgia School of Technology.

Paul Schlosser, Research Manager, Rayonier, Inc., Shelton, Wash., a 1922 graduate of Darmstadt University with an Eng.D. degree.

Gengo Shoji, Director, Honshu Paper Mfg. Co., Ltd., Tokyo, Japan, a 1924 graduate of Tohoku University.

Bernard A. Sobel, Chemist, Peter J. Schweitzer, Inc., Spotswood, N. J., a 1939 graduate of Cooper Union.

Minoru Tanaka, Mill Manager, Nakatsu Mill, Honshu Paper Mfg. Co., Ltd., Gifu Pref., Japan, a graduate of Tokyo University.

Joseph M. Theberge, Assistant Chemist, Merrimac Paper Co., Inc., Lawrence, Mass. Attended Lowell Textile Institute.

Norman W. Touchette, Textile Technologist, Fulton Bag & Cotton Mills, Atlanta, Ga., a 1950 graduate of the Institute of Textile Technology.

Jan Unander-Scharin, Bowaters Svenska Tramassefabriker A/B, Umea, Sweden.

Russell E. Vannatta, Chief Engineer, The Excello Paper Produce Co., Cincinnati, Ohio. Attended Rensselaer Polytechnic Institute.

Antonio Vismara, General Manager, Cartiera di S. Cesario S.p.A., Milano, Italy, a 1939 graduate of Politecnico di Milano with an Eng.D. degree.

Joshua J. Ward, Jr., General Power and Maintenance Superintendent, Union Bag & Paper Corp., Savannah, Ga., a 1933 graduate of Clemson A & M College.

Harry W. Winkler, Chief Chemist, Cooperative Refinery Association, Coffeyville, Kan., a 1932 graduate of Kansas University.

Sadao Yamagishi, Manager, Honshu Paper Mfg. Co., Ltd., Tokyo, Japan, a 1926 graduate of Kiryu Technical College.

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Satoshi Yamanouchi, Vice-President, Honshu Paper Mfg. Co., Ltd., Tokyo, Japan, a 1918 graduate of Kyushu University.

Shiroemon Yazawa, Director, Honshu Paper Mfg. Co., Ltd., Tokyo, Japan, a graduate of Tohoku University.

TAPPI Notes

Hans Baars, formerly of Celdecor Africa (Pty) Ltd., is now Pulp and Paper Expert for the U.N. Food and Agriculture Organization, Benoni, Transvaal, South Africa.

J. Edmund Becker, formerly of the Chase Bag Co., is now Production Manager of Alton Boxboard Co., Alton, Ill.

Norbert Bernheimer, formerly Consulting Engineer, has retired and is at present located in Middlebury, Vt.

Geoffrey Broughton, formerly of the Lowell Textile Institute, is now Head of the Chemical Engineering Dept., University of Rochester, Rochester, N. Y.

Peter Calott, Chemical Engineer from the American Cyanamid Co., has been transferred from New York City to St. Louis, Mo.

George L. Clarke, formerly of the Kimberly Clark Corp., is now Production Manager of Coosa River Newsprint Co., Coosa Pines, Ala.

Grellet N. Collins, Consulting Engineer, has transferred his office from New York City to 407 Woodside Ave., Narberth, Pa.

William F. Connolly, formerly of Wm. H. Welsh Co., Inc., is now Research Engineer for the Vat-Craft Corp., New York, N. Y.

C. M. Connor is now Vice-President of W. C. Hamilton & Sons, Miquon, Pa.

Ralph M. Cook, Jr., formerly of the Calco Chemical Div., American Cyanamid Co., is now Research Chemist for Hollingsworth & Whitney Co., Waterville. Me.

Warren F. Daniell is now Chief Engineer of the Great Northern Paper Co., Millinocket, Me.

T. E. Detcher, formerly of the Barrett Div., is now Chemical Engineer in the Nitrogen Div., Allied Chemical & Dye Corp., Evans Mills, N. Y.

J. H. Dutruc, formerly of Papeteries T. B. Weibel, is now Pulp Mill Superintendent of CENPA, Papeteries de Novillars, Novillars, Doubs, France.

Aarno J. Esila, who has been studying in the United States, is now Design Engineer for A/B Kemi Oy, Karibaara, Finland.

Kristian Fougner is now Assistant to the Vice-President in Charge of Operations for A/S Borregaard, Sarpsborg, Norway.

Kenneth M. Gayer, formerly of the Keever Starch Co., is now Director of Research for the Ogilvie Flour Mills, Co., Ltd., Montreal, Que.

William H. Harding, formerly of the American Cyanamid Co., is now Assistant to the President of the National Gypsum Co., Buffalo, N. Y.

Walter L. Hardy, formerly of Ledpak, Inc., is now Director of Paper and Package Engineering for Foster D. Snell, Inc., New York, N. Y.

Arthur H. Hupp, formerly Student at Western Michigan College, is now Chemist for the Michigan Paper Co., Plainwell, Mich.

James B. Hyde, formerly of the Western Waxed Paper Div., is now Administrative Operating Assistant for the Crown Zellerbach Corp., San Francisco, Calif.

George E. Jackson is now Assistant Superintendent of Rayonier, Inc., Fernandina, Fla.

Nicholas A. Jappe is now Technical Director of Coos Bay Pulp Corp., Seattle, Wash.

John M. Jernigan is now Technical Service Director of the Southern Div. of Reichhold Chemicals, Inc., Tuscaloosa, Ala.

Russell M. Jones is now Manager of Product Development for the Nitrogen Div., Allied Chemical & Dye Corp., New York, N. Y.

Raphael Katzen is now Manager of the Engineering Div. of the Vulcan Copper & Supply Co., Cincinnati, Ohio.

William H. Kibbel, Jr., Technical Sales Representative of the Becco Sales Corp., has transferred from Buffalo, N. Y., to Vancouver, Wash.

C. E. Libby, formerly Head of the Pulp and Paper Dept., New York State College of Forestry, is now Professor of Pulp and Paper Technology in the School of Forestry, North Carolina State College of Agriculture and Engineering, Raleigh, N. C.

Charles W. E. Locke, formerly Chief Engineer, is now General Manager of the Harmac Pulp Div. of MacMillan & Bloedel Ltd., Nanaimo, B. C.

Frank W. Lorey, formerly Student at the New York State College of Forestry, has joined the Research staff of the Mead Corp., Chillicothe, Ohio.

Donald Macaulay is now President of Paper Quality Control, Inc., Chappaqua, N. Y.

Thomas F. Martin, Jr., is now Technical Director of the Hartford City Paper Co., Hartford City, Ind.

Monroe J. Mason, formerly of Anheuser-Busch, Inc., is now Assistant Technical Director of the Starch Div. in Charge of Research Development and Control of the Union Starch & Refining Co., Granite City, Ill.

William H. McPherson is now Supervisor of Paper Research for the Minnesota and Ontario Paper Co., International Falls, Minn.

George W. Mead II, formerly Student at The Institute of Paper Chemistry, is now Chemical Engineer for the Consolidated Water Power & Paper Co. Wisconsin Rapids, Wis.

Donald F. Meyer, formerly of the Central Paper Co., is now Development Chemist for the Pennsylvania Salt Mfg. Co., Wyandotte, Mich.

Robert A. Negaard is now Supervisor of Quality Control for the Paper Div. of the Continental Can Co., Memphis, Tenn.

Donald H. Newcomb is now Sales Engineer, for the Riegel Paper Corp., New York, N. Y.

Merrill J. Osborne, formerly Electrical Engineer for the Crossett Paper Mills, is now with the Bowater's Southern Paper Corp., Athens, Tenn., and Greenville, S. C.

Robert S. Painter, formerly Graduate Student, Bucknell University, is now Research Chemist for Celanese Corp. of America, Summit, N. J.

Clifford B. Pape, Plant Manager and Technical Director of the Aluminum Rolling Mills, Ltd., has transferred from Trois Riviers, Que., to Cap de la Madeleine, Que.

Harold L. Peckham, formerly of the Manhattan Pulp & Paper Co., is now Technical Director of the Paper Corp. of the United States, New York.

Roderick A. Perkins, formerly Student at the Western Michigan College, is now in the Technical Dept., Marinette Paper Co., Div., Scott Paper Co., Marinette, Wis.

Ernest A. Richardson, formerly of the Orange Pulp & Paper Co., is now Technical Director of the Ancram Paper Mills, Ancram, N. Y.

Richard W. Roberts, formerly of the International Paper Co., Mobile, Ala., is now Research Chemist, Central Research Dept., Marathon Corp., Rothschild, Wis.

Lucien G. Rolland is now Vice-President and General Manager of the Rolland Paper Co., Ltd., St. Jerome, Que.

Michael S. Shenk, formerly of the Atwood Adhesives Co., is now Research Consultant for Adhesives Resistol, Mexico City, Mex.

Hervey J. Skinner is now Vice-President of American Conditioning House, Inc., Boston, Mass.

Charles A. Southwick, Jr., formerly Consultant, Package Engineering Service, Hope, N. J., is now Technical Director in Charge of Research and Development for the H. P. Smith Paper Co., Chicago, Ill.

Edward J. Sullivan, formerly of George W. Millar & Co., is now Manager of the Specialty Paper Dept., H. G. Craig & Co., Inc., New York, N. Y.

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Victor J. Sutton, Executive Director of Bowater's Development and Research, Ltd., London, Eng., is on loan as Assistant General Manager of Bowater's Southern Paper Corp., Greenville, S. C.

Robert M. True is now Branch Manager of the General Dyestuff Corp., San Francisco, Calif.

Paul E. Truttschel, formerly of the Georgia Kaolin Co., is now a member of the Sales Staff of the Appleton Coated Paper Co., Appleton, Wis.

William G. Van Beckum, formerly of the Weyerhaeuser Timber Co., is now Director of Research for the Pacific Lumber Co., San Francisco, Calif.

Robert F. Van Derveer, Sales Engineer for SKF Industries, Inc., has transferred from Philadelphia, Pa., to Detroit, Mich.

Harold F. Wood, Jr., is now Assistant Manager, Knife Products, Heppenstall Co., Pittsburgh, Pa.

* * *

Edward J. Peal, General Sales Manager, has succeeded *Clarence P. Robinson* (deceased) as the official representative of the Kidder Press Co., Dover, N. H., in TAPPI.

Albert C. Mahana has succeeded *C. D. DeMers* (retired) as the official representative of Taylor Instrument Co., Rochester, N. Y., in the Technical Association.

Industry Notes

Wood Pulp

Wood pulp production during the first four months of 1952 amounted to 5,636,000 tons, an increase of 3% over the corresponding 1951 period. Pulp consumption amounted to 5,902,000 tons. Imports amounted to 638,408 tons, a decrease of 20%. Imports from Canada decreased 9%, and from Europe, 56%. Exports amounted to 90,000 tons, an increase of 30%. Wood pulp inventories at the end of April were 671,000 tons, an increase of 30,000 tons over inventories at the end of March, and an increase of 167,000 tons over inventories at the end of April, 1951.

Wastepaper

Wastepaper receipts, through April, amounted to 2,582,000 tons, a decline of 26% under receipts for corresponding months in 1951. Consumption totaled 2,581,000 tons, a decline of 23% under consumption for the same 1951 period. Inventories at the end of April were 588,000, an increase of 2% over inventories at the end of March and an increase of 22% over inventories at the end of April, 1951.

An estimate of the nation's wastepaper consumption during the first half of 1952 is by paperboard mills, 2,750,000 tons; by paper mills, 550,000 tons; by roofing and building materials mills, 320,000 tons; and by wet machine board mills, 40,000 tons; total 3,660,000 tons.

A fraction over 30% of the paper and paperboard consumed by the people of the United States last year was recovered, packed, and sold to the paper, paperboard, and building materials mills for reuse. In all, it amounted to 9,252,000 tons. But what became of the remaining 70%? Could it have been reused if it had been salvaged? Certainly a part of it could have been, but a great deal of it was unfit for reuse because it had been made into wet-strength papers and board, or treated with plastics, adhesives, inks, waxes, etc., that made it insoluble in the repulping processes. Such papers bring the worries to the wastepaper packers and the mills alike because in some instances they cannot be identified or distinguished from other papers until they go into the beaters at the mills.

During the month of March, according to the Bureau of Census, the paper mills produced 949,916 tons of paper on all classes, and consumed in production 904,970 tons of wood pulp and 100,577 tons of wastepaper. The paperboard mills produced 917,594 tons of paperboard, consuming 459,832 tons of wood pulp and 489,990 tons of wastepaper. The wet machine board mills, manufacturers of binder's board, shoe board, etc., produced 8798 tons, consuming 719 tons of pulp and 6546 tons of wastepaper. Mills manufacturing construction paper and board turned out 196,050 tons of their product, consuming 138,952 tons of pulp and 53,437 tons of wastepaper.

To give one an idea of the amount of various kinds of paper manufactured in March that cannot be recovered for reuse, here are cited the following: sanitary tissue, 98,924 tons; napkins, 12,427 tons; absorbent papers, 10,653 tons; papers for asphalting, 20,613 tons; cigarette papers, 3193 tons; carbonizing paper, 3094 tons; waxing papers, 15,249 tons; glassine, greaseproof, and vegetable parchment, 713 tons; gumming papers, 8175 tons; gelatin and spirit process duplicating papers, 5222 tons; map and chart papers, 2040 tons, and others, including wet-strength ledgers and bags and ledgers printed with indelible inks.

Among the paperboards, 65,467 tons of foodboards were manufactured in March for milk bottles, ice cream pails, frozen food containers, butter, oleo, and shortening cartons. Paperboard for tubes and cans amounted to 24,696 tons. Many folding and setup boxes to which cellophane and plastics were added were manufactured by converters from paperboard, as well as containers impregnated with resins and chemicals for special purposes and for making them waterproof.

Some of the consumers of old newspapers cannot use the highly colored supplements, and some even object to color in the regular news sections. Magazines printed with certain types of inks are objectionable to the paper mills, and many of the new adhesives used by book and magazine publishers make their publications taboo with certain mills.

So, in view of this, it may be said that the ratio of wastepaper recovery to total consumption at 30.1% in 1951 was quite high. The record was during the war—in 1944—when it went to 35.6. Consumption that year was about two-thirds what it was last year.

With an increasing number of inimical ingredients appearing in the various papers and paperboard products, the work of the wastepaper packer becomes increasingly difficult, because, for instance, the appearance of a single sheet of carbon paper would contaminate an entire bale of paperstock. A great deal of attention is now being given by the consuming mills, the packers, and dealers to develop methods whereby more of the valued fibers of used paper and board can be recovered and reclaimed, a project of great merit.

S.S. *United States*

During the course of construction of the superliner S.S. *United States*, about 600 draftsmen at the Newport News Shipbuilding and Dry Dock Co. produced 8400 detailed drawings, from which 1,200,000 working blue prints were made. These blueprints represented 145,000 lb. of paper, the capacity of two full freight cars. They would, if extended end to end, form a paper pathway 510 miles long and 30 in. wide. To make patterns for certain small components and assemblies for the vessel, 128 rolls of template (wax-coated) paper, weighing 18 tons, were consumed. If rolled out flat on the ground, this paper would cover an area of more than 15 acres. An additional 5 tons of common heavy duty draft paper were used for packing and other purposes.

Philippines

A Norwegian expert, working in the Philippines under the United Nations technical assistance program, has recommended—after an eight-month survey—the construction of six pulp and paper mills having a total annual production of 282,000 tons of pulp. Of that amount, 100,000 tons will be converted into paper and paper products, and the remainder will be available for export. It is contemplated that the mills will also have an annual production of 60,000 tons of wallboard and 60,000,000 board feet of lumber.

THE FOURTH DICALITE PLANT

...will add approximately 80% increased production capacity for Dicalite calcined and processed filteraids and fillers

The new plant of the Dicalite Division, Great Lakes Carbon Corporation, at Lompoc, Calif., is now in volume production at a continually increasing rate. It represents over 5 years of engineering, design and construction, and is the largest complete unit for processing diatomite built in the last 22 years. Full designed output will add approximately 80% increased production capacity for Dicalite calcined and processed filteraids, fillers and other materials.

This increased production capacity insures a plentiful supply of Dicalite products for the future. Users can be confident of dependable delivery, with four plants in operation, chances of interrupted supply are greatly reduced.

Advanced design of the new plant has afforded greater operating flexibility and extended processing ranges. Specifications for performance and quality of each product are readily maintained. Research data are being accumulated to aid in developing new and improved Dicalite products for future industrial use.

DICALITE DIVISION GREAT LAKES CARBON CORPORATION

GLC

NEW YORK 17 • CHICAGO 1 • LOS ANGELES 17

Films Pertaining to the Paper Industry[a]

Company	Title	Subject	Sound	Width, mm.	Running time	Miscellaneous
American Forest Products Industries, 1319—18th St., N. W., Washington 6, D. C.	From Trees to Paper	Scientific forest management	Yes	16	13 min.	Crop management, from forest to paper
American Forest Products Industries, 1319—18th St., N. W., Washington 6, D. C.	Trees for Tomorrow	Forest management	Yes	16	20 min.	Forests for all purposes—lumber, paper, recreation, etc.
American Pulpwood Assn., 220 E. 42nd St., New York, N. Y. Att.: William Bromley	The Story of Mechanical Pulpwood Production	.....	No	16	1½ hr.	Technical, showing late developments in equipment
The Stanley Bowmar Co., rep. Society for Visual Education, 513 W. 166th St., New York 32, N. Y.	A Trip Through a Paper Mill	Manufacturing from raw logs to finished product	No	35	...	Black and white, with manual for slide lecturing; 32 frames. For sale only
Brown Co., Berlin, N. H.	Forest and the Woodsman	Logging operations; preparation of pulpwood	Yes	16	30 min.	Safety measures in logging
Brown Co., Berlin, N. H.	Helpful Hints in Preparing Pulpwood	Training and safety	Yes	16	15 min.	Safety measures in forests
Brown Co., Berlin, N. H.	Pulpwood for Today and Tomorrow	Forestry	Yes	16	20 min.	Continuous forest crops for the future
Brown Co., Berlin, N. H.	Wood Handling Safety	Safety measures	Yes	35	30 min.	Proper methods of handling pulpwood from pile to clippers. Sound slides
Brunswick Pulp & Paper Co., Brunswick, Ga. Att.: E. J. Gayner	Mill Operations of Brunswick Pulp & Paper Co.	.....	No	16	35 min.	General interest including some forestry
Brunswick Pulp & Paper Co., Brunswick, Ga. Att.: E. J. Gayner	Woods Operations of Brunswick Pulp & Paper Co.	.....	No	16	45 min.	General interest including some forestry
Castle Films, Inc., RCA Bldg., Rockefeller Plaza, New York, N. Y.	Treasures of the Forest	Manufacturing from logs into lumber and pulp	Yes	16	15 min.	Cutting and transportation of wood, for lumber and pulp
Chicago *Tribune*, Public Service Office, 33 W. Madison, Chicago 11, Ill.	Trees to Tribune	Timber to newspaper	Yes	16	30 min.	Outstanding photography, logging, paper to Tribunes. Ideal story, new picture
Coronet Films, Coronet Bldg., Chicago 1, Ill.	Papermaking	Logging, manufacturing, testing	Yes	16	20 min.	Start in forests. Very accurate in detail
Coronet Films, Coronet Bldg., Chicago 1, Ill.	How to Read Newspapers	.....	Yes	16	16 min.	Very good for schools, 6th, 7th and 8th grades
Curtis Publishing Co., Independence Square, Philadelphia, Pa.	Magazine Magic	Magazine printing	Yes	16	27 min.	Story of magazine printing from planting of seedlings to newsstand
Curtis Publishing Co., Independence Square, Philadelphia, Pa.	Our Philadelphia Story	Various steps in producing a magazine	Yes	16	45 min.	.....
Encyclopedia Britannica Films, Inc., Wilmette, Ill. Att.: E. F. Hoya, Sales Dept.	From Tree to Newspaper	Papermaking	No	16	18 min.	Black and white. From forest to printed newspaper
Encyclopedia Britannica Films, Inc., Wilmette, Ill. Att.: E. F. Hoya, Sales Dept.	Paper	Papermaking	No	16	...	Fundamentals of the paper industry
Encyclopedia Britannica Films, Inc., 1150 Wilmette, Wilmette, Ill.	Making a Book	Paper manufacturing and book making	Yes	16	15 min.	Technical steps in the process, very fine
Forest Industries, Information Committee of Minn., 516 Lyceum Bldg., Duluth, Minn.	Harvesting the Forest Crop in Minnesota	Logging of pulpwood and sawlogs with old and newer methods	No	16	33 min. (sound speed); 45 min. (silent speed)	Interesting equipment, sawmills, peeling, water transportation, Christmas tree harvesting, natural reproduction, nursery tree planting, areas protected for scenic attraction
P. H. Glatfelter Co., Spring Grove, Pa. Att.: Mrs. A. N. Baker	A Short Course in Papermaking	Papermaking	Yes	16	35 min.	Color film; papermaking from tree to finished products
General Electric Co., Visual Education Section, 570 Lexington Ave., New York, N. Y.	World of Paper	Beginnings of writing, discovery of paper, modern paper production	..	16	30 min.	.....
Hammermill Paper Co., Erie, Pa. Att.: Mrs. M. E. Maloney	The Gift of Tsai Lun	Historical; from invention of paper to modern papermaking	Yes	16	30 min.	Partly color, partly black and white; from standing timber to final shipment
Hammermill Paper Co., Erie, Pa. Att.: Mrs. M. E. Maloney	Voice of Business	Story of Hammermill Bond from cutting of log to finished product	No	16	40 min.	.....
F. C. Huyck, Kenwood Mills, Albany 1, N. Y.	Paper—Pacemaker of Progress	Historical, what paper has done for civilization	Yes	16	26 min.	Film and book on request. Paper's contribution to progress

SOUTHERN CLAYS INC.

Manufacturers of

LUSTRA

WHITETEX

COLUMBIA COATING CLAY

COLUMBIA WATER WASHED FILLER CLAY

33 Rector St.

New York 6, N. Y.

Films Pertaining to the Paper Industry (*Continued*)[a]

Company	Title	Subject	Sound	Width, mm.	Running time	Miscellaneous
International Harvester Co., Inc., 180 N. Michigan, Chicago 1, Ill.	Monarchs of the Forest	International Harvester equipment in northwest	Yes	16	23 min.	Good story and photography
International Paper Co., 220 E. 42nd St., New York, N. Y. Att.: John Tower	In Partnership with Nature	Forest management and conservation	Yes	16	33 min.	Allow sufficient time for mailing
Masonite Corp., 46 Washington Blvd., Oshkosh, Wis.	The Story of Preswood	Development of Masonite products from experimental stage of present-day usage	No	35	..	Filmstrips. Shows manufacturing process
Strathmore Paper Co., West Springfield, Mass. Att.: Al Gibney	A Trip Through the Strathmore Mills	.....	No	16	20 30 min.	.....
State College of Washington, Audio-Visual, Pullman, Wash.	Magic Fiber	Pulpmaking and logging	Yes	16	25 min.	.....
Union Bag & Paper Corp., 233 Broadway, New York, N. Y.	Green Gold	Forest management	Yes	16	25 min.	Technicolor
U. S. Forest Service, I & E Div., Washington 25, D. C., or each Regional Office	River Run	Forest management and driving	Yes	16	15 min.	Remarkable voice for this setting. Very good plug for forest management. Excellent photography
Zellerbach Paper Corp., 343 Sansome St., San Francisco, Calif. Att.: V. E. Hecht	Fresh and Good Looking	Use of product	Yes	16	30 min.	The conversion and use of paper in the food industry
Zellerbach Paper Corp., 343 Sansome St., San Francisco, Calif. Att.: V. E. Hecht	Forests for the Future	Forest management	Yes	16	26 min.	Color

[a] Those interested in showing a film should communicate with the owner listed in column 1 for terms and conditions of use. Many of these films are available under certain conditions without charge. This list was compiled by the American Paper & Pulp Assn.

Corporate Giving

The National Planning Association, 80 21st St., Washington 6, D. C., has issued a helpful book "Manual of Corporate Giving" (Price $6.75). This book should be useful to many companies that are giving attention to systematic giving. It shows how to avoid legal pitfalls and get tax benefits.

Union Bag

Four college scholarships have been awarded by the Union Bag & Paper Corp., Savannah, Ga. The awards of $4000 each ($1000 each year) were made to W. M. Gruber, D. B. Kennedy, R. L. Simerly, and M. E. Ellis, Jr., all of Savannah, and sons of employees at the Savannah plant. More than 40 young men of Savannah and Chatham County applied for the scholarships. The selections were made by a committee consisting of J. R. Lientz, Manager of the Savannah plant's pulp and paper division; P. R. Narmore, Dean of the Georgia School of Technology; Alvin B. Biscoe, Dean of the University of Georgia; R. L. Sumwalt, Dean of Engineering of the University of South Carolina; and A. W. Boldt, Association Dean of the University of Florida. The four winners of the awards have expressed a desire to attend the Georgia School of Technology.

T. T. Dunn, vice president and resident manager of Union Bag's Savannah plant, center, extends best wishes to the four winners of the company's college scholarships. Each scholarship carries a $4,000 cash award for the four year college term. Left to right: William M. Gruber, Danny B. Kennedy, Mr. Dunn, Marvin Earl Ellis, Jr., and Roberly L. Simerly.

New Swedish Mill

Plans for a new kraft pulp mill in southern Sweden have been recently announced by leaders in the Swedish Forest Owners Federation. The plans are backed by various farmer organizations and are based on their opinion that there will be a surplus of pine pulpwood in the southern parts of the country during the coming years. The mill is planned for the east coast of Sweden near Kalmar and will have an annual capacity of 30,000 tons minimum. Cost of the mill is figured at Sw. Kr. 50,000,000 (U.S. $10,000,000). Construction is expected to begin in the Fall of 1953 with production scheduled for 1956.

P.C.U.S.

Harold L. Peckham has been appointed Technical Director of the Paper Corp. of the United States, New York, N. Y. Mr. Peckham was formerly with the Hammermill Paper Co. and Green & Low Paper Co.

Powell River

Powell River Co., Powell River, B. C., has installed two new Watrous magazine grinders. These machines are the largest grinders in existence and are specially designed to handle 64-in. blocks. The over-all installation cost $1,200,000.

With a 64-in. bin, it is possible to use two 32-in. blocks. Each of the machines will grind 60 to 70 tons of pulp daily, compared with the present 15 tons per day average. 9000 hp. is required to drive the two grinders.

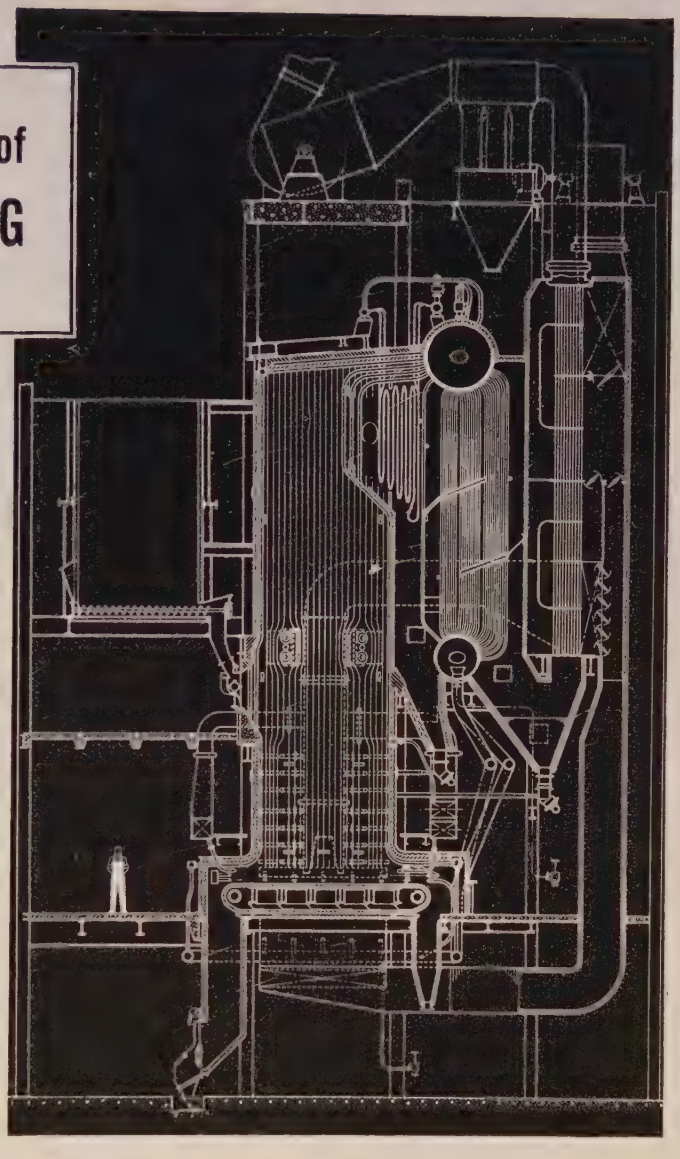
Consolidated Water Power & Paper Co.

Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., has contracted with Iowa State College, Ames, Iowa to carry on a two-year study of the usefulness of Torula yeast as a nutritional supplement in hog feeding. Yeast is being supplied by the Rhinelander Paper Co., which has the only American yeast process plant for treating spent sulphite liquor.

Now you can Burn Bark

reliably • efficiently • economically . . .

. . .with the new C-E method of
SUSPENSION BURNING



Here is a revolutionary, new bark burning method — proved in service — that will soon be paying impressive dividends to prominent pulp and paper mills all over the country. Several companies have units, similar to that illustrated, in service, under construction or on order.

Suspension burning — primary feature of the new C-E system — overcomes the drawbacks of former bark burning methods.

Bark or hogged wood is fed into the furnace by specially designed spreader units at a considerable distance above the grate level. Preheated combustion air is introduced through rows of nozzles arranged to assure extreme turbulence in the furnace.

Caught in a swirling gas mass, the bark is flash dried and most of it burns in suspension. The remainder — a very small proportion — burns quickly and evenly on the grate.

The C-E method has proved highly successful in burning oil in combination with bark or hogged wood — or for burning oil alone when desired.

Reports from the initial installation — now in service for more than a year — show that overall savings have been very substantial, that performance has been excellent and that availability is exceptionally high — actually better than 99 per cent.

So if you have bark, wood refuse or other cellulose waste materials to utilize, you will want to know more about this new method. The services of the Combustion organization are freely available to your engineers and consultants.

COMBUSTION ENGINEERING—SUPERHEATER, INC.

200 Madison Avenue • New York 16, N. Y.

B-582

PRODUCTS FOR THE PAPER INDUSTRY INCLUDE RECOVERY UNITS, STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; ALSO PRESSURE VESSELS

Crossett

Kenneth G. Chesley, Director of Research, Crossett Lumber Co., Crossett, Ark., has been elected President of the Forest Products Research Society.

In "Forest Echoes," Crossett's House Organ, the following rules for safety were published recently:

1. Goggles must be worn at all times when there is any danger of an eye injury.
2. Do not wear loose clothing, neckties, finger rings, or other jewelry when working on or around moving machinery.
3. Never use an air hose to clean off hair or clothing or point it at another person.
4. Report unsafe conditions to your foreman, superintendent, or safety guide immediately.
5. Employees other than electricians or mechanics must not tamper with electrical or mechanical equipment.
6. Safeguards must not be removed except by order of your foreman or superintendent.
7. Horseplay and practical joking will not be tolerated.
8. Smoking is allowed only in authorized areas.
9. Report all injuries, no matter how slight, to your foreman.
10. Practice good housekeeping. This means clean working areas and machines, also tools and equipment in their proper place when not in use.

N.Y.S.C.F.

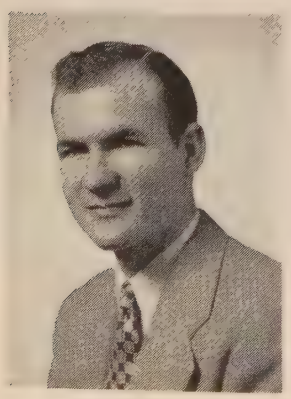
The State University of New York, College of Forestry, Syracuse, N. Y., has been reorganized into three divisions embracing ten of the twelve academic departments, including two new departments. The new departments are forest chemistry and forest economics, outgrowths of the long-established department of pulp and paper technology and forest management, respectively.

Two positi ns of Associate Dean have been created. Edwin C. Jahn, Director of Research, has been designated Associate Dean for the Physical Sciences, and continues to direct research. The Associate Dean for the Biological Sciences has not been appointed. Dr. Jahn, Professor of Forest Chemistry, has been appointed Acting Head of Forest Chemistry.

An average starting salary of $365 a month for positions in the paper industry was accepted by 14 seniors in pulp and paper technology graduated in June. The class brought to 455 the number of men and women graduated by Professor Libby in the 32 years since he helped organize the training in pulp and paper technology at the College of Forestry. He leaves the department staffed with 30 persons and laboratories and a full-size paper mill with a replacement value of one million dollars.

H. P. Smith

Charles A. Southwick, Jr., has been appointed Technical Director in Charge of Research and Development for the H. P. Smith Paper Co., Chicago, Ill., makers of specialty packaging papers. Mr. Southwick has been engaged in consulting work at Hope, N. J. Formerly he was with Shellmar Products Corp. and was a pioneer in the study of water vapor permeability of papers.



Thomas G. Zentner, Gardner Board & Carton Co.

Charles A. Southwick, Jr., H. P. Smith Paper Co.

Steele Medal

Thomas G. Zentner, who graduated from The Institute of Paper Chemistry in June, was awarded the Westbrook Steele gold medal. The medal is awarded to a candidate for the doctorate degree for presenting an outstanding thesis. Mr. Zentner is from San Angelo, Tex., and is now employed by the Gardner Board and Carton Co., Middletown, Ohio.

Community Relations

A major activity of the American Paper and Pulp Association is its Community Relations Program. Its Director, Donald M. Rochester, has indicated the various media that can be used in promoting this program. These follow:

1. Employee magazines.
2. Information racks.
3. Tour booklets.
4. Management letters.
5. Bulletin boards.
6. Employee recreational associations.
7. Guided tours.
8. Open house.
9. Economic education
10. Opinion surveys.
11. Foreman's clubs.
12. Employee handbooks
13. Industrial fairs.
14. Civic affairs programs.
15. Press and radio relations (visitations back and forth are important).
16. Correspondence courses.
17. School cooperation.
18. Communications and the supervisor.
19. Scholarship programs.

Largest Paper Cup Plant

Lily-Tulip Cup Corp. has recently dedicated its new paper cup and container plant erected at Springfield, Mo. It is a 1000-ft. plant enclosing a 10-acre area devoted to the manufacture of these products. The Springfield plant is Lily-Tulip's ninth.

Kimberly-Clark

Disposable plate processing towels made especially for lithographic platemakers are now being offered by the Kimberly-Clark Corp. in a new package under the trademark of Litho Wipes. The new package consists of 2400 towels, with 300 towels to the bundle and eight bundles to the shipping container. The towels have been on the market for more than 20 years under the designation of "whipcord embossed Kinpak." More than 500 lithographers are using them for washing out deep-etch plates with alcohol and for other wiping operations.

Glass Fibers

Glass Fibers, Inc., 1810 Madison Ave., Toledo 2, Ohio, has issued a bulletin on "Micro-Fibers" describing the use of glass fibers (diameter less than 14 millionths of an inch) for forming a sheet by papermaking operations including beaters and fourdrinier paper machines.

West Virginia

Another major phase in the postwar rehabilitation of the Covington, Va., plant of West Virginia Pulp and Paper Co. was achieved when the plant's new streamlined pulp mill was placed in full operation for the first time, company officials announced today.

The new mill, with modern "push-button" operations for cooking, washing, and screening pulp, is expected to be one of the most efficient units of its kind in the country.

The pulp mill is designed to produce chemical pine and hardwood pulp by the sulphate process, for use in the manu-

Sulphur

Molten Sulphur flowing into the storage vat

Thousands of tons mined daily, but where does it all go?

Look around you in any grocery store and what do you see — canned goods of all kinds! Soups, vegetables, fruits, berries! Believe it or not, you're looking at merchandise that consumed a lot of Sulphur in the making.

Tin cans are made of tin plate. Tin plate is made of sheet steel. Sheet steel is made with the help of sulphuric acid—pickling, as they call it, the process that removes scale preparatory to plating. In 1951, the sheet division of our great iron and steel industry is estimated to have consumed 140,000 long tons of Sulphur in the form of sulphuric acid. That in itself makes quite a dent in our supplies of Sulphur. Add to this almost as much more for treating wire rod, plate, strip, bars, etc., and you can see that to make finished steel, regardless of form, the iron and steel industry must use lots of Sulphur in the form of sulphuric acid.

Right here is an excellent example of the interdependence of all of our industries. To produce steel requires a lot of Sulphur. To produce Sulphur and other mined products requires a lot of steel. This interdependence of industries is one of the country's sources of strength.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.

Mines: Newgulf and Moss Bluff, Texas

The new consolidated chip house at Covington, Va., plant of West Virginia Pulp & Paper Co. is equipped with new type ground level chip bins, equipped with intricate conveyor belt and elevator systems which deliver chips to digesters and semichemical cookers. Bins at right are for hardwood chips, those at left for pine. Bins store 15-hr. chip supply, about triple the capacity of old bins, which were located in buildings above digesters

facture of such grades as sanitary food container, kraft envelope, and printing papers. It also makes semichemical pulp from hardwood for use in the manufacture of nine-point board for corrugating.

Built on the site of the old No. 2 pulp mill, the new installation consolidates, on the east side of Jackson River, all the plant's wood pulp manufacturing operations, except bleaching. It replaces No. 1 pulp mill on the west side of the river as well as No. 2 mill, and matches the output of both mills.

In combination with a new consolidated woodyard and chipping layout, placed in operation about a year ago, the new pulp mill gives the plant centralized, straight-line operations for both pine and hardwood from the time pulpwood is received in the yard until the pulp is made and ready for bleaching.

The only pulp processing operation remaining on the west side of the river is the bleach room, formerly a part of No. 1 pulp mill, which will continue to operate in its present location. Through two 18-inch pipe lines three-quarters of a mile long, unbleached pulp is pumped from the new consolidated mill to the bleach room.

"The pulp mill project is an important part of a broad rehabilitation program launched after the war to adapt a larger part of Covington's facilities to the manufacture of food container papers," Crawley Williams, manager of the Covington plant, pointed out. "These papers, used in the manufacture of paper cups, milk bottles, food and liquid containers of all types, provide us with a new and growing market which may eventually restore the Covington mill to the competititve position it once occupied in the industry."

The postwar program called for the rebuilding of some of Covington's prime-producing paper machines, replacement of obsolete paper machines with new equipment, further mechanization of pulpwood handling and preparation facilities, building of a completely new pulp mill, and modernization of power and service facilities, a large part of which is now completed.

There was some question at the outset as to whether it would be feasible to modernize the scattered pulping facilities at Covington without a long shutdown and serious production losses. The plant was operating two pulp mills—one a pine sulphate mill on the east side of the river, the other a combined hardwood and pine sulphate mill, as well as a semichemical pulp plant, on the west side of the river. Both pine and hardwood pulp were bleached on the west side. Eventually, however, company engineers devised a "jigsaw" plan of construction which made it possible to achieve the change while maintaining nearly normal production.

The job not only tested the ingenuity and inventiveness of the company's engineering and operating staffs, but, because of the great number of job changes, transfers, and reassignments involved, resulted in unprecedented activity in the fields of personnel relations and job training.

To accomplish the mechanical changes, the mill's engineering and construction crews first began late in 1950 to erect a new steel-and-tile building adjacent to No. 2 pulp mill, along with a new extension to the old digester house of that mill.

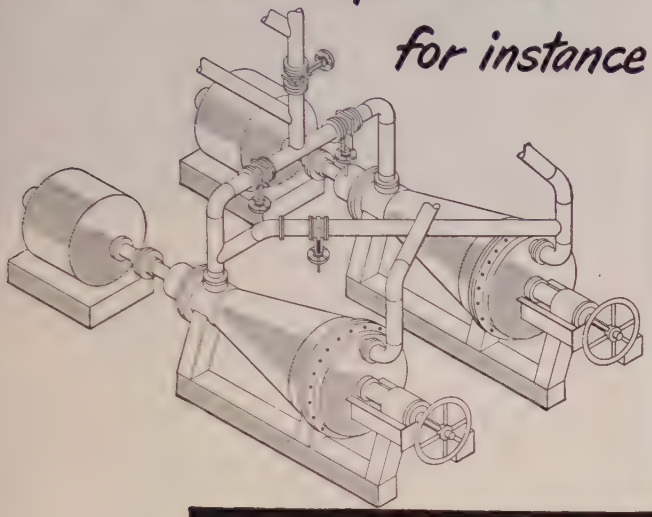
As soon as space in the new buildings was available, crews began installing new equipment capable of taking over the production of No. 2 pulp mill. When a new facility was completed, fully tested under operating conditions, and finally placed in operation, old units in No. 2 pulp mill were shut down and dismantled. Then additional new facilities to replace No. 1 pulp mill were added at the new consolidated mill.

The consolidation was accomplished in four stages. The first was completed in March, 1951, when a line of three rotary vacuum washers for pine pulp was installed to replace old style wash pans in the No. 2 pulp mill. Two months later, the second stage was completed when two semichemical pulp-making units from No. 1 pulp mill were relocated in the new consolidated pulp mill, a new semichemical continuous pulp cooker was placed in operation, a second line of two-stage washers for semichemical pulp was installed, and No. 1

This general view of the new consolidated pulp mill at the Covington, Va., plant of West Virginia Pulp & Paper Co. shows the new steel-and-tile building erected adjacent to the old no. 2 pulp mill and the new addition to the digester house. In the foreground (right) are digester blow tanks; (center) hot water accumulator, and (left) filtrate liquor tanks of hardwood line of pulp washers

Can Your Valves Match these Ratings?

...on 4% Pulp Stock for instance



THE INSTALLATION

On pulp stock lines in Jordan room at Chase Bag Company mill, Chagrin Falls, Ohio.

VALVE SERVICE RATINGS

SUITABILITY:	Beats any others used
MAINTENANCE COST:	None—Routine only
CORROSION-RESISTANCE:	No problem here
SERVICE LIFE:	In 5 years—no sign of wear
OPERATING RESULTS:	Shutdowns eliminated
PRICE:	In line
AVAILABILITY:	Local Crane Supplier

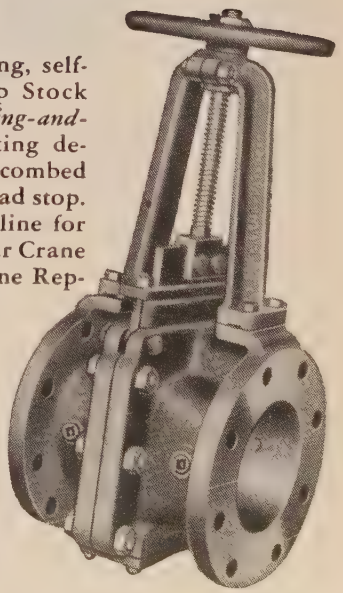
THE HISTORY

Valves formerly used caused excessively frequent shutdowns for cleanout of clogged lines. Pulp trapped in seats and bonnets; valves inoperative. *Working conditions:* Consistency of stock normally about 4%. Pipe and valve size, 8 in. throughout system. Operation continuous; valves operated infrequently.

Replacements made with Crane Pulp Stock Valves. Now in service more than 5 years, with routine maintenance only, Crane valves have not required a single shutdown. Clogging of lines completely stopped.

THE VALVE

Crane No. 1425 non-clogging, self-cleaning, bonnet-less Pulp Stock Valves with patented *combing-and-shearing-action* disc and seating design. Knife-edge disc shears combed fibers to seat easily against lead stop. One of the complete Crane line for pulp and paper mills. See your Crane Catalog or consult your Crane Representative.



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Low cost Pitch and Asphalt control based upon sound chemical principles. P-A-D dissolves pitch or asphalt out of your system.

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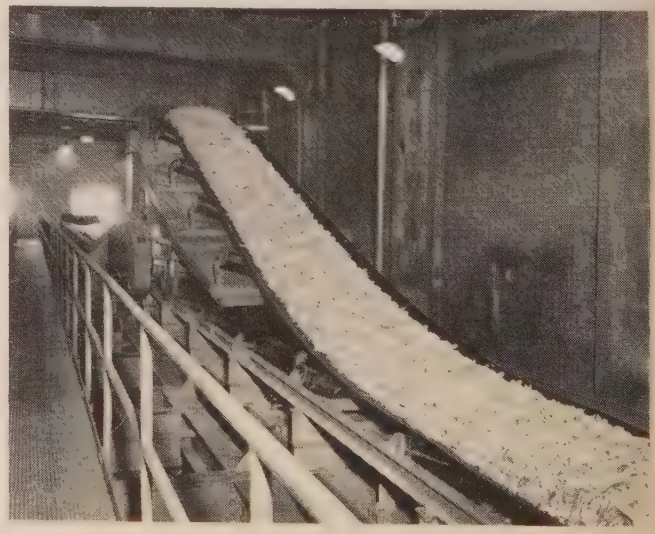
View of the new caustic liquor works at the Covington, Va., plant of West Virginia Pulp & Paper Co., showing the 350-ft. lime kiln, surrounded by clarifying tanks, lime mud washers, storage bins and other installations. The caustic liquor works processes recovered pulp cooking liquor for re-use in the pulp mill

chipper was moved to the site of No. 2 chip house, adjacent to the new consolidated pulp mill.

The third stage was completed in July, 1951, when four automatically controlled digesters, each capable of cooking 50 tons of chips at a time, were placed in operation, replacing six smaller digesters of No. 2 pulp mill. Then the six old digesters were dismantled to make room for six additional new digesters.

The final stage of the consolidation took place June 9 when No. 1 pulp mill, which had been operating since the plant was first built in 1900, was shut down and all pulp cooking, washing, and unbleached screening operations were transferred to the new consolidated pulp mill. This involved the start-up of a third line of rotary vacuum washers for hard-



Digesters in the new consolidated pulp mill at the Covington, Va., plant are charged with chips by a conveyor and tripper system. Here chips travel on conveyor located above the digesters. The tripper is positioned by push-button stations located by each digester on the chip-charging floor

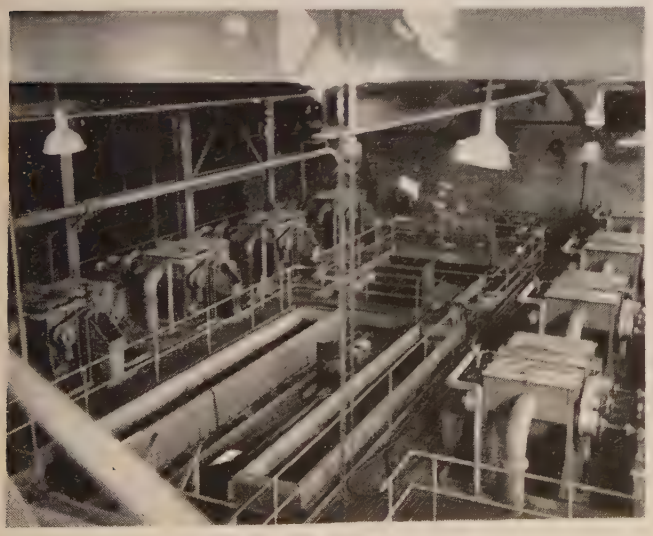
Digester operating floor of new consolidated pulp mill of West Virginia Pulp & Paper Co. The pulp mill has a line of 10 digesters, each capable of cooking 50 tons of chips at a time. At the right can be seen the instrumentation panel room, where details of all pulp cooking operations are recorded. Digesters are equipped with automatic liquor charging devices, liquor circulating systems and other automatic controls which assure better quality and uniformity of pulp

wood and the new screen room, equipped with 10 new vibratory screen units, which replace 68 flat screens formerly used in No. 1 and No. 2 pulp mills. At the same time, the six new digesters which had been brought into operation as completed, began full production.

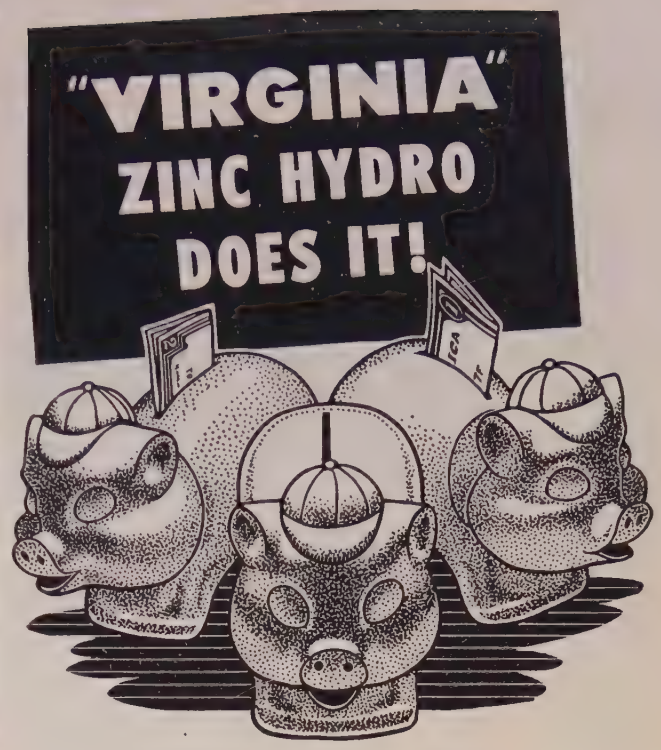
Although most of the basic operating changes have now been finished, several additional pulp mill projects are still to be carried out. One is the erection of four tile tanks, capable of storing 400 tons of unbleached pulp, which will provide a reservoir ahead of the bleach room. The tanks will be equipped with thickeners for high density storage.

The personnel planning which accompanied the pulp mill change-over was just as complex and detailed as the engineering.

Company officials and representatives of Local 675, United Paperworkers of America (CIO), held a long series of detailed discussions, reviewing at length the seniority, the promotional status, and other factors of each employee in the pulp mill, in an effort to arrive at an equitable solution to the problem of job assignments.



The screen room is equipped with 10 new type vibrating screens and auxiliary equipment. This unit replaces 68 flat screens previously operated in no. 1 and no. 2 pulp mills



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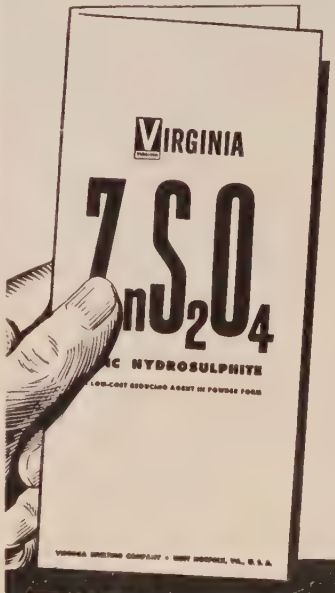
"Virginia" Zinc Hydro is widely used in the paper industry as one of the most *effective* brightening and decolorizing agents available for groundwood. "Virginia" Zinc Hydro is also one of the most *economical*. Please note the three important ways it contributes to economy: 1) its cost per ton of pulp is low; 2) the cost in capital investment of converting to its use is low; and 3) no auxiliary chemicals are required.



We urge your investigation of these economy claims for "Virginia" Zinc Hydrosulphite. When you find them to be soundly based, your interest in "Virginia" Zinc Hydrosulphite should be considerably whetted. Why not write today for a free test sample and our recommendations for its use.

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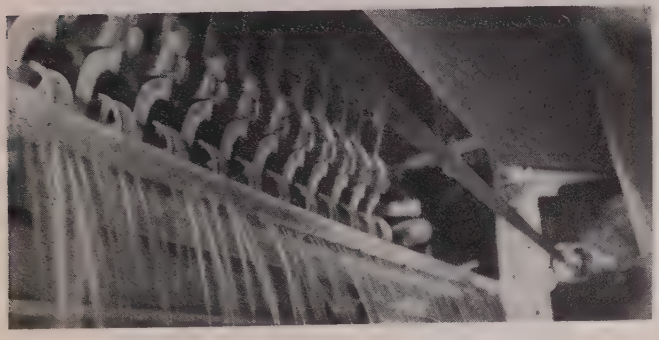

THE LONGER you can run felts before having to shut down for cleaning — the better will be your production record. And you can greatly increase running time on any felt if you

RECONDITION REGULARLY WITH THE CLEANER THAT SUITS *YOUR* OPERATIONS

Magnus Feltex
Magnus Felt Cleaner
Magnus NX
Magnus Acidex

One (or possibly two) of these felt conditioners will give you restored openness and nap... softness and removal of residues... depending on the nature of the furnish, sizes, colors and finishes you use. We'd like to cooperate with you in selecting the material that will do the most to boost running time for your felts. Remember, too, that each of these conditioners can be used to speed up breaking in of new felts... hold felts in condition over week-end shut-downs... and for cleaning felts off the machines.

Longer felt running time is discussed in detail on pages 23 to 30 of the Magnus Paper Mill Cleaning Handbook. Look it up... or write for a copy if you do not have one handy.

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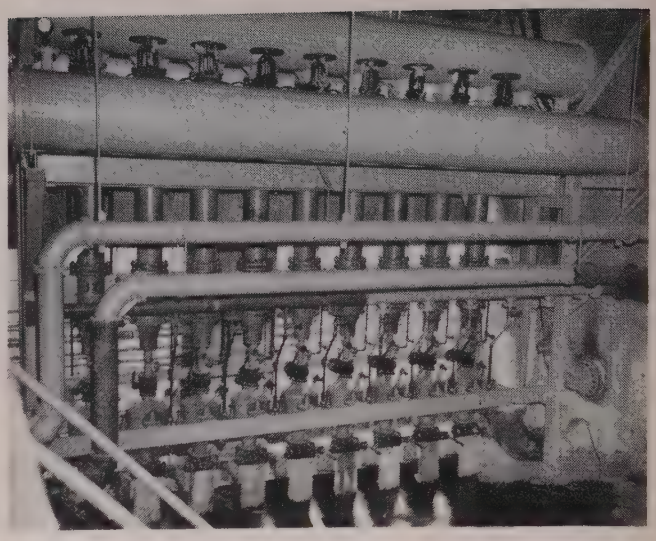
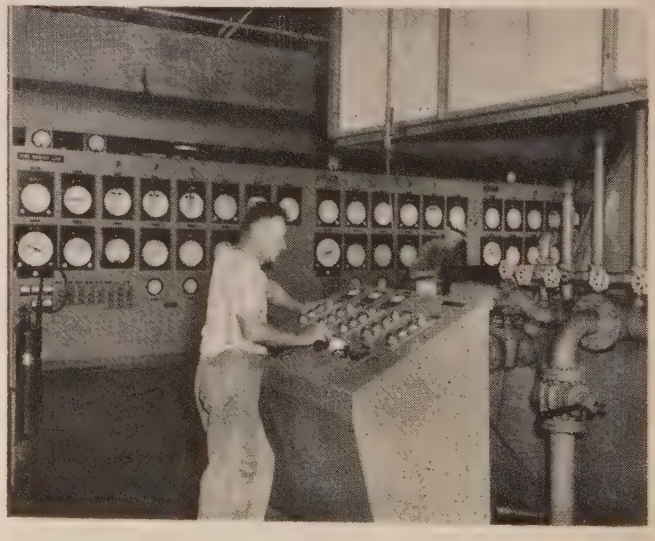


View of the primary Vortrap system in the consolidated pulp mill of the Covington, Va., plant of West Virginia Pulp & Paper Co. The unit removes grit and dirt from pulp before it is pumped to the bleaching room

The reassignment of employees to jobs in the pulp mill during the course of the consolidation and at the final stage required the organization of a broad training program in order to acquaint operators with the new equipment and, in most cases, to familiarize employees with entirely new jobs.

Varying periods of training were given each employee assigned to a job different than he had hitherto performed or to a job where the duties had been expanded or revised, either during the transition period or in the final assignments. In the final assignments, the system followed placed more than 95% of the pulp mill workers in jobs different from those they had performed prior to the consolidation.

"Although the entire program has been extremely costly and difficult to administer," Plant Manager Williams said, "the company feels that it has been worth both the effort and the money to arrive at an equitable distribution of jobs, find places throughout the mill for as many employees as possible, and to maintain the high operating standards required in these days of increasing competition in our industry."



Extent of the automatic controls and instrumentation incorporated in equipment in the new consolidated pulp mill is illustrated by this view of the rotary washer room showing R. C. McKinney, assistant operator (foreground), at console control panel, and John Harrison, operator, filling out operating report forms at desk. In background is instrumentation board which records operating data for all three rotary vacuum washers. Each line of washers has individual operating console

Another important installation recently began operations at the Covington plant when the new caustic liquor works went into full-scale production.

The most imposing piece of equipment in the layout is a lime kiln, 11 ft. in diameter and 350 ft. in length. Believed to be one of the largest now in use in the paper industry, the kiln is capable of producing up to 275 tons of lime per day.

The kiln stacks are equipped with specially designed scrubbers which, according to engineers' estimates, will operate at well over 90% efficiency in removing dust from waste gases. Plant officials said the scrubbers should bring about a noticeable improvement in dirt conditions in the community.

Other equipment in the layout includes lime storage bins, conveyors, lime slakers, six primary causticizers, a white liquor clarifier, two secondary causticizers, lime mud washers, density controllers, lime mud storage tank, a ferris wheel feeder, and two centrifuges.

The entire system is fully instrumented, with automatic controls throughout, assuring the mill of a plentiful supply of cooking liquor of the highest quality and uniformity.

The old liquor works, which included three small lime kilns, has been shut down and will be dismantled.

Suppliers Consolidated Pulp Mill, Covington, Va.

Construction work and installation, Rust Engineering Co.
Electrical installation, Davis H. Elliott Co., Rao Electrical Co. and mill forces
Semichemical continuous cooker, Messing & Durkee
Asplund defibrator, American Defibrator Co.
Hot stock refiners, Sutherland Refiner Corp.
Digesters, Blaw Knox Co.
Digester blow heat recovery system, Foster Wheeler Co.
Digester circulating system, Electric Steel & Foundry Co.
Digester liquor circulating pumps, Morris Machine Works
Heat exchangers, Graham Manufacturing Co.
Digester controls, instruments, Mason-Neilan Regulator Co., Minneapolis-Honeywell Regulator Co.
Miscellaneous instrumentation, Brown Instrument Div.
Digester blowoff valves (Sphero), Fairbanks Co., and Limitorque remote control unit, Philadelphia Gear Works
Rotary disk feeders, Chain Belt Co.
Hood and exhaust systems, J. O. Ross Engineering Corp.
Agitators, Improved Paper Machinery Co.
Propeller agitator, Shartle Brothers Machine Co.
Vibrator screens, Bird Machine Co.
Flat screens, Improved Paper Machinery Co.
Hummer screens, W. S. Tyler Co.
Waco filter, Improved Paper Machinery Co.
Vibratory de-knotters, Improved Paper Machinery Co.
Magnetic pulley, Magnetic Engineering and Manufacturing Co.
Valveless vacuum decker, Improved Paper Machinery Co.
Miscellaneous pumps, Ingersoll-Rand Co., Warren Steam Pump Co., Viking Pump Co. and Milton-Roy Co.
Consistency regulators, DeZurik Shower Co.
Roto-Sleeve meters, Fischer and Porter Co.
Vortraps, Nichols Engineering and Research Co.

Suppliers Caustic Liquor Works, Covington, Va.

Lime kiln, Traylor Engineering and Manufacturing Co.
Continuous causticizing system, Dorr Co.
Instrumentation, Leeds and Northrup, Republic Flow Meter Co., Foxboro Co., Hays Corp., and Brown Instrument Div.
Pumps, Worthington Pump and Machinery Corp.
Scrubbers, Peabody Engineering Co. and Traylor Engineering and Manufacturing Co.
Centrifuges, Bird Machine Co.
Pressure filters, Roberts Filter Manufacturing Co.

LIGNOSOL

The official opening of the $1¼-million plant of Lignosol Chemicals Ltd. by Quebec's Prime Minister Maurice L. Duplessis, last June in Quebec City, climaxed a decade of patient research and steady development which brought about the invention, the production, and the sale of new products useful to industry.

Lignosol derives from spent sulphite liquor, a by-product of chemical wood pulp, and it comes in liquid and in powder forms. It is used in road building as a soil stabilizer; in the manufacture of leather, as a dye leveling agent; as a cement dispersant, an adhesive for gummed tapes, a ceramic

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Among its many uses are:-

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Write For Bulletin 1000 — with diagrams showing the variety of operations for which the low cost Ecco coater can be used, along with construction details, prices, etc.

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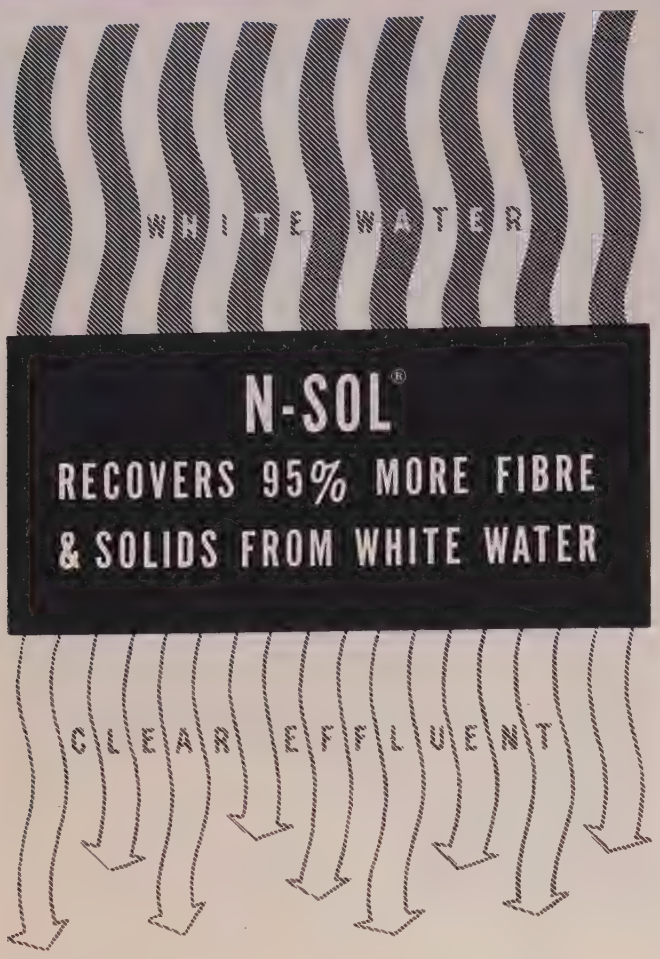

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N-Sol (activated silica sol) is prepared conveniently at your mill from N Silicate of Soda and a reactant chemical. Request samples of "N" and directions for jar tests today.

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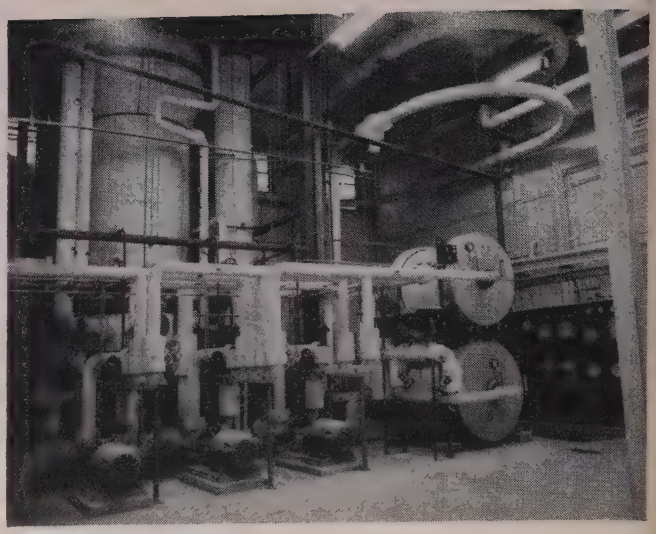

The heart of the Lignosol plant is this room containing the evaporator in the background, the panel board, and the heat exchangers (right foreground), the feed and distillate pumps, at left. Total height: approximately 40 ft.

plasticizer, a foundry core binder, a refractory binder, and as an additive in electrolytic copper refining.

Lignosol Chemicals Ltd. was incorporated two years ago with a capitalization of $5,000,000 supplied jointly by the Anglo Newfoundland Development Co., of Grand Falls, Newfoundland, and the Anglo Canadian Pulp and Paper Mills Ltd., of Quebec City.

The productive capacity of its plant is 22,500 tons per annum, of which some 40% is exported to the U.S.A. Close to 100% of the plant's raw materials come from the Province of Quebec. Sales for 1951, which was the first production year, totaled $230,000, while they are estimated at $400,000 for this year, and at $750,000 for 1953.

F. T. Atkinson, M.C., of Quebec City, is President and General Manager of Lignosol, whose Chairman of the Board is E. M. Little, also of Quebec City, President and General Manager of Anglo Canadian Pulp and Paper Mills Ltd.

Lignosol is more than a new name in the industrial chemical field. It is part of a new phase of growth within the pulp and paper industry. Yet, the potential for its manufacture has existed since wood was first converted to pulp by the acid sulphite process. For Lignosol in all its forms is a derivative of lignin, a material made available in the production of wood pulp by this chemical process.

In the acid sulphite process, chipped wood is cooked in a chemical solution. This dissolves out the lignin, wood sugars, and other soluble substances which form about half the dry weight of the wood, leaving sulphite pulp. The resultant solution, or spent sulphite liquor as it is known in the pulp and paper industry, is the source of this lignin supply.

The idea of making use of this ready supply of lignin is not new. In the past, several methods of extraction have been introduced and are being used with varying degrees of success. It was felt that more efficient extraction methods could be devised and that many new industrial applications could be evolved. This is indeed proving to be the case. However, in the beginning, many of the products now cataloged were merely ideas; their uses were speculations.

The recovery of lignin from spent sulphite liquor would probably be universal, were it not for two major problems. First, this liquor contains a large proportion of water which must be removed economically. Second, it contains calcium sulphate which forms a scale on the heat exchange surfaces during concentration, and soon prevents the necessary heat transfer. It was these difficulties which had greatly curtailed recovery of lignin in the past.

It was in 1943, at Chandler, a town on the coast of the Bay of Chaleur in Quebec, that a pilot plant was first built for

the production of Lignosol. The plant consisted of open wooden tanks in which the spent liquor was boiled until it reached a concentration of 50% by weight. It was then ready for sale, but in liquid form only. As time harvested experience, additions and modifications were made, and the Chandler pilot plant came to form the nucleus for Lignosol development during the next nine years.

Lignosol was first used by the Quebec Roads Dept. for highway stabilization around the Gaspé Peninsula. Its value was soon evident, and the technique of application improved with practice. Today, over 600 miles of highway have been treated.

At the same time other uses were being established and proved. In addition to use as a binding and stabilizing agent for gravel roads and air strips, prior to paving, Lignosol was finding markets in various other fields.

Many of the best markets called for modified products, and in 1944 the first new type of Lignosol was produced. This was Lignosol T, known to the tanning industry as "spruce extract," and used in the tanning of leather.

At this stage, the need for a good balance between research, production, and sales was also becoming an important factor. While much had been accomplished without a sales force specifically assigned to Lignosol, its absence now became more keenly felt as research indicated new potentials for the products. Accordingly, a Lignosol sales staff was appointed.

The results were gratifying: the market for older applications was widened; customers' suggestions for improvements and applications began to flow in more quickly; other information from the field stimulated new lines of development. The sales force has continued to prove as valuable in bringing in information as in disseminating it to potential customers.

One immediate outcome of this added source of information was emphasis on the need for a powdered product. A spray drier was installed for the production of powdered Lignosol, and new markets were opened up where it had previously been impractical to ship liquids.

Lignosol SF, used in the manufacture of Portland cement, and in a cement plasticizing and dispersing product, was the first of the new series of modified products to result from this impetus.

Demand for this material grew very rapidly, and it became one of the most important forms of Lignosol. Two new types of Lignosol T were also developed, and were well received by the tanning industry.

An adhesive for gummed tape followed. New core binders, ceramic plasticizers, grinding aids, products for pelleting, and dispersants are some of the most recent developments. The search for new products goes on at an accelerating pace, and more and more industrial problems are finding their solution in Lignosol.

Meanwhile, studies were going forward on the development of new production equipment that would reduce evaporation costs, eliminate the scaling problem, and widen the range of Lignosol products. Most notable result was the thermal compression evaporator. A pilot plant was first built at Chandler, and its operation studies and design altered until it was finally modified to meet the requirements for efficient concentration of the spent sulphite liquor.

Adaptation of this evaporator and the virtual elimination of the scaling problem were noteworthy achievements. A paper given on this subject by members of the Lignosol technical staff, at the 1950 meeting of the Technical Section of the Canadian Pulp and Paper Association, won for the authors the Weldon Medal, awarded annually for the best research of the preceding year.

The Chandler pilot plant had been expanded to keep pace with sales until it finally became a production unit. However, by 1948 the existing facilities were obviously inadequate to meet growing customer requirements. The original plant had served its purpose of establishing markets and uses for

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NEUTRAL SULFITE PULP MANUFACTURERS have avoided costly delays and shut-downs by using Ansul Liquid Sulfur Dioxide to manufacture their own sodium or ammonium sulfite.

And the Ansul "Controlled SO_2 System" eliminates the need for burner gas, decreases costs and provides efficiencies well worth investigating.

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ALSO MANUFACTURERS OF REFRIGERANTS, REFRIGERATION PRODUCTS AND DRY CHEMICAL FIRE EXTINGUISHERS

Heedless of drizzling rains Clyde B. Morgan, President of Rayonier, Inc., keynotes ground breaking ceremonies for his company's new $25,000,000 Chemical Cellulose Plant at Doctortown, Ga. Also braving the rains are James T. Sheehy, Executive Vice President (with hat), and seen to the right, Robert L. Lingelbach, Rayonier Secretary and Clark Gaines, Director of the Georgia Chamber of Commerce

Lignosol, and the time had come to rebuild and reorganize. Design was begun for a completely new plant in Quebec City. Construction started in 1951, and early the following year all equipment had been delivered and installed. The official opening of the plant was held last June.

The new Quebec plant, which also houses the company offices, turns to practical advantage the findings of the earlier development studies. From the new thermal compression evaporator to the streamlined packaging and shipping facilities, every possible improvement has been incorporated for the most efficient production of Lignosol. Excellent laboratories support a continuing program of research, development, and testing. Their staff is always available to help investigate promising new applications of the product, and to assist those seeking special modifications to meet specific requirements.

All Lignosol powders are light tan to brown in color. They form dark brown solutions. All are freely soluble in water. Where both liquid and powdered grades are available, the suffix D is used to distinguish the latter.

Lignosol B and BD	Calcium lignosulphonate	Soil stabilization; refractory binder; foundry core binder; ceramic plasticizer; adhesive
Lignosol T	Lignosulphonic acid	Manufacture of leather
Lignosol N and ND	Magnesium lignosulphonate	Manufacture of leather. Dye leveling agent
Lignosol SF	Sugar-free calcium lignosulfonate	Cement dispersant
Lignosol A	Formulated lignosulfonate	Adhesive for gummed tape
	Development Products	
Lignosol TS	Ammonium lignosulphonate	Manufacture of leather; dispersant
Lignosol X	Sodium lignosulphonate	Dispersant; ceramic plasticizer
Lignosol SFX	Sugar-free sodium lignosulphonate	Dispersant; additive in electrolytic copper refining

Liquid products are shipped in tank cars or packed in 500-lb. drums. Powdered products are packed in 5-ply moisture-proof kraft bags, weighing 75 lb. each. A minimum carload is 50,000 lb. in Canada, 40,000 lb. in the United States.

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RAYONIER

An architect's rendering shows Rayonier, Inc.'s, new chemical cellulose plant currently under construction at Doctortown, Ga. When completed early in 1954, the $25,000,000 mill, the company's fifth, will add 87,000 tons of purified wood cellulose to Rayonier's annual output.

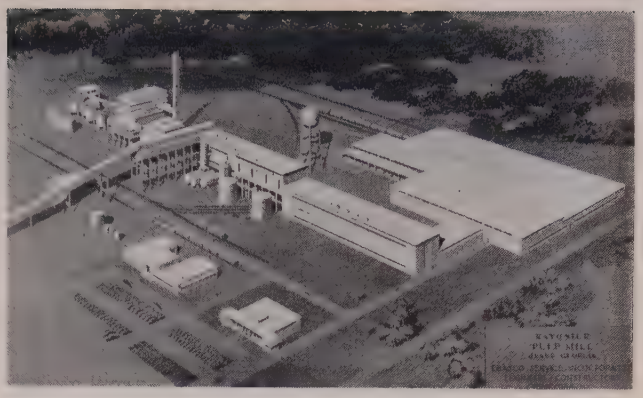
Rayonier President Clyde B. Morgan explained during ground breaking ceremonies last June 5 that the mill would be "the most modern in the world." It will incorporate new processes and techniques just developed by the company's research and engineering divisions.

Mr. Morgan unhesitatingly said the product will be the "finest to be produced commercially anywhere in the world," and noted that the plant is being built in such a fashion that its daily capacity of 250 tons of chemically pure wood cellulose may be doubled or quadrupled in the future.

The appointment of Thomas Reber Stein as Resident Manager of Rayonier, Inc.'s, new $25,000,000 purified wood cellulose plant currently under construction at Doctortown, Wayne County, Ga., has been announced by James T. Sheehy, Rayonier's Executive Vice-President. A native of Sunbury, Pa., and holding a degree in mechanical engineering from Bucknell University, Mr. Stein has been closely associated with the cellulose industry since 1937. He was formerly resident manager of the Minnesota and Ontario Paper Co. Before joining Rayonier he served as Assistant Manager in Charge of Engineering and Construction for the Wood Conversion Co. of Cloquet, Minn. Early in his professional career Mr. Stein was an Engineer in the turbine and compressor division of the General Electric Co. at Syracuse, N. Y.

BUCKEYE

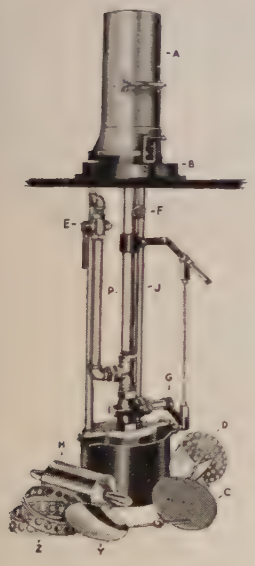
The equipment for the previously announced new mill of the Buckeye Cellulose Corp. now being built at Foley, Fla., has now been selected. Contracts for the complete modern bleach plant consisting of the Sandy Hill Kamyr type of multistage bleaching and pulp forming and drying machine have been awarded. The Buckeye Cellulose Corp. is a subsidiary of Procter and Gamble Co. The pulp-forming machine will consist of a 180-in. wire width removable fourdrinier, a special press unit, driers, reel, and sheeter. The new machine will be driven by a Sandy Hill selective drive. Plans for the projected plant are being drawn by J. E. Sirrine Co. of Greenville, S. C., and Buckeye engineers.



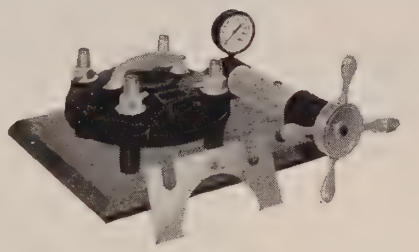
Architect's sketch of the new Rayonier plant at Doctortown, Ga.

HUDSON

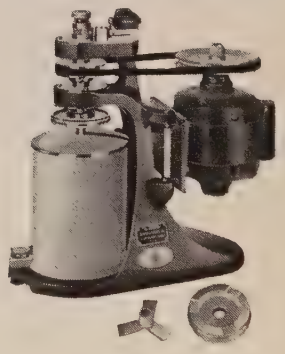
The Palatka, Fla., Div. of the Hudson Pulp & Paper Corp. was presented with a special award by the American Mutual Liability Insurance Co. on April 18. The award was presented in consideration of the fact that during the calendar year of 1951 this Hudson mill accumulated 729,963 man-hours of work without a lost time accident. The award was received for the company by J. L. Richardson, Resident Manager of the mill. This award was made to the bag mills



★ SHEET MACHINE
DRYER RINGS
AUXILIARY EQUIPMENT



★ PUMP AND PRESS



★ DISINTEGRATOR

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Fibre Classification Grid—Used With Sheet Machine in Place of Standard Grid Plate

Also: Clark's Laboratory Kollergang Beater

THE HERMANN MANUFACTURING CO.

HERMANN IMPROVED CLAFLIN REFINER

LANCASTER, OHIO

under the supervision of J. S. George, Superintendent, John Williamson, Supervisor of Multiwall Converting Dept. and Clarence Eastman, Supervisor of the Grocery Bag Dept. The Palatka operation is Hudson's largest kraft mill. It produces gummed sealing tape, of which it is the largest producer in the world, under the Orange Core and Blue Ribbon brands, multiwall sacks, grocery bags and sacks, butchers' paper, kraft wrapping, and jumbo rolls for numerous converters of kraft paper products. John Brett, Safety Director of the Palatka mill, stated that plans are being made to attempt to maintain and improve the fine record made during 1951.

Zellerbach

J. D. Zellerbach, President of Crown Zellerbach Corp., has been decorated with the Star of Italian Solidarity, First Class, highest civilian award of the Italian government. Before an audience of 1000 Italian-American citizens in San Francisco on June 24, 1952, Minister Justo Giusti del Giardino, Rome, special emissary of Italy's President de Gasperi, presented the Star to Mr. Zellerbach "as an appreciation by the Italian government for the constructive work he did as administrator of ECA for two years in Italy."

Minister Giardino said in part: "Because Mr. Zellerbach went everywhere to study the needs of our people, nearly everyone in Italy feels that they know him. Few people understand our ways as he does. Our nation is grateful."

Bemis Bag

Recent modernization of facilities at Bemis Bro. Bag Co. in Peoria, Ill., featured a new clay coating plant for the production of coated paper for flour bags. The aim in providing these facilities was to process high-quality flour sack paper at high speeds. To realize maximum production on the Merrill Coater, it was equipped with a Kohler Model 42, three-arm

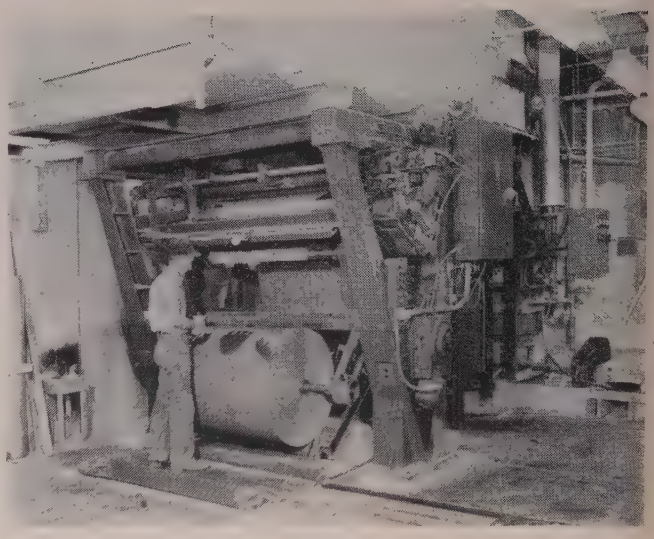
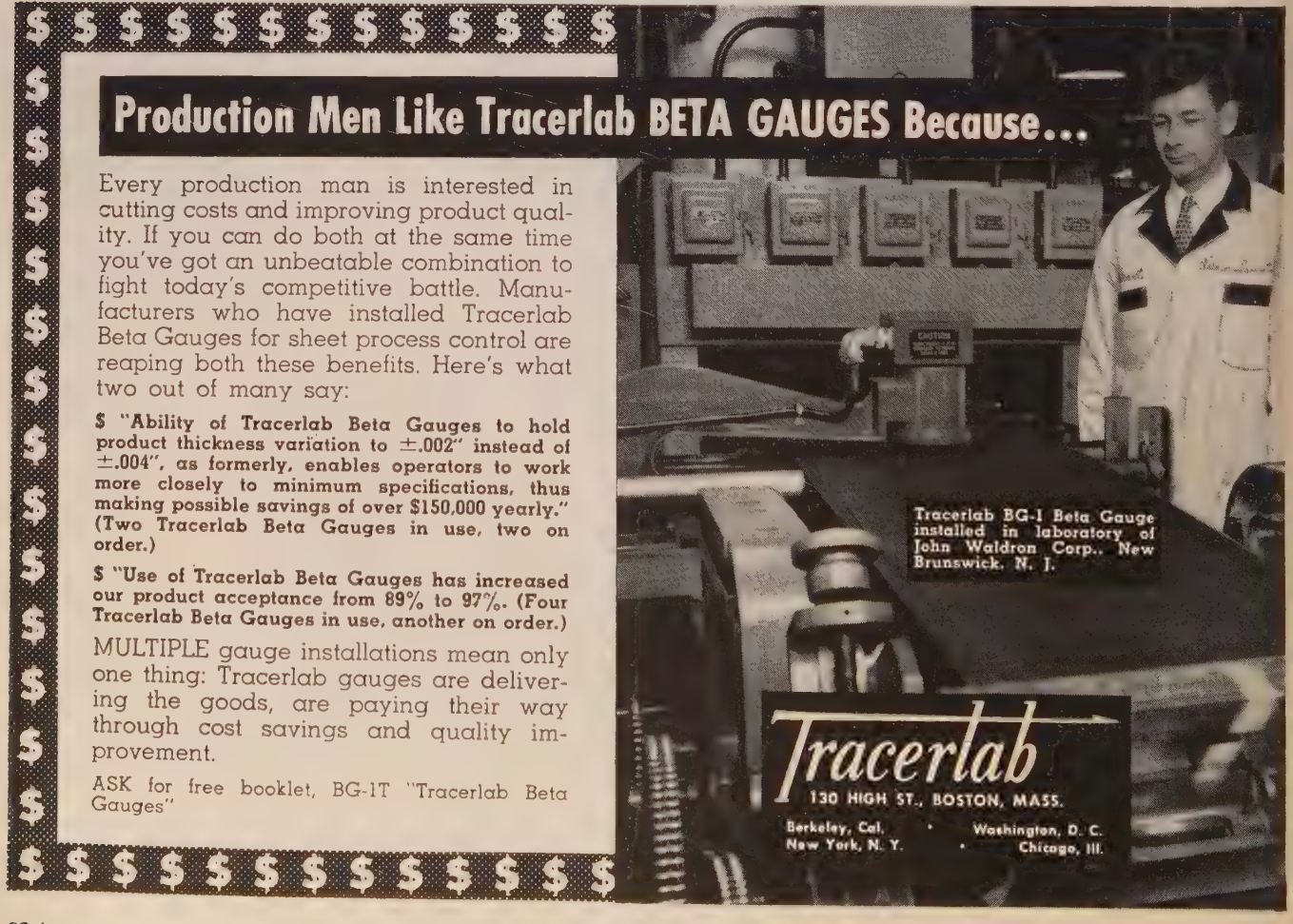


Fig. 1

unwind reel featuring the running belt tension, and overhead flying paster. For continuous winding operation, a Kohler Model 42, heavy-duty reel with flying starter and double enveloper is used.

This coating line was engineered by Dilts Machine Works, Div. of the Black-Clawson Co., in conjunction with C. J. Merrill & Son for production of up to 850 f.p.m.

The Kohler unwind reel is designed for a maximum web width of 62 in., a 40-in. diameter roll weighing 3000 lb., wound on a 3 or 8-in. core, tensions from 1 up to 6 lb./in., and for flying splices at 850 f.p.m. The pasting mechanism is supported overhead on cast iron superstructure along with the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$ "Ability of Tracerlab Beta Gauges to hold product thickness variation to ±.002" instead of ±.004", as formerly, enables operators to work more closely to minimum specifications, thus making possible savings of over $150,000 yearly." (Two Tracerlab Beta Gauges in use, two on order.)
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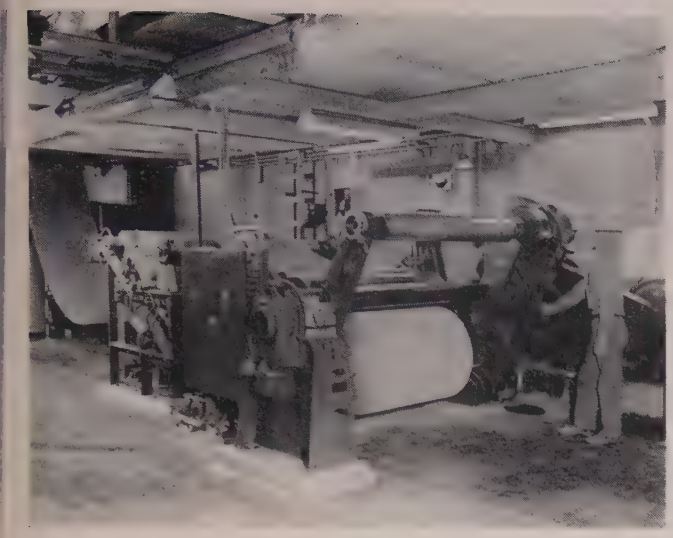

Fig. 2

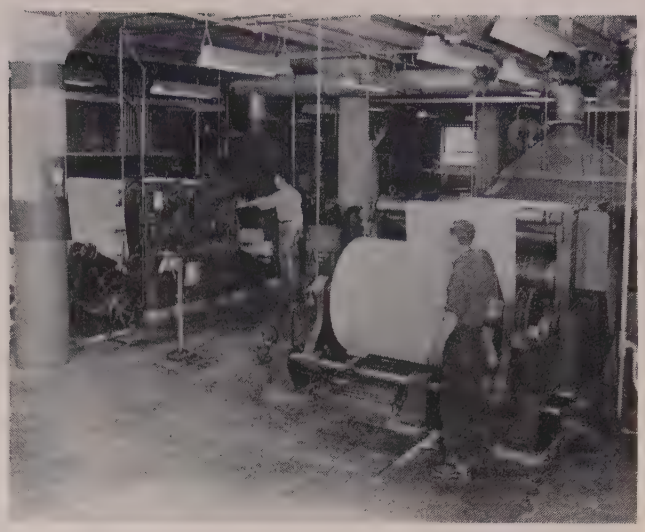

Fig. 3

belt tension mechanism to leave free access for the unwind loading zone as shown in Fig. 1.

The Kohler winder reel shown in Fig. 2 is designed to make flying starts at 850 f.p.m. through use of a new patented feature, the double envelopment of the web about the new core. This reel can wind rolls 60 in. wide, 40 in. diameter, and weighing 3000 lb. under tensions ranging from 1 lb./in. up to 6 lb./in.

Although flour sack paper is coated one side only, the equipment provides a unique feature in that the unwind reel and rewind reel are installed back to back and use a common loading area, so that a roll coming off the winder can be chucked into the unwind reel and coated on the reverse side, if desired, without rewinding the roll or turning over the web. To date, continuous production speeds of 800 f.p.m. have been realized.

In conjunction with the new coating line, two new Dilts double embossers were also installed for flour bag manufacture. The large machine has a roll face of 66 in. and the small machine has a 47-in. roll face.

The complete line consists of an air-braked shaftless unwind stand with quick lockup chucks (Fig. 3), the double embosser, a brush polishing section hooded for dust collection, and a "Camachine" slitter-winder.

A unique feature of the embossers is that a change in pattern can be made without shutting down the machine, since two sets of embossing rollers, each with a different pattern, are set in each machine, and the threading arrangement is

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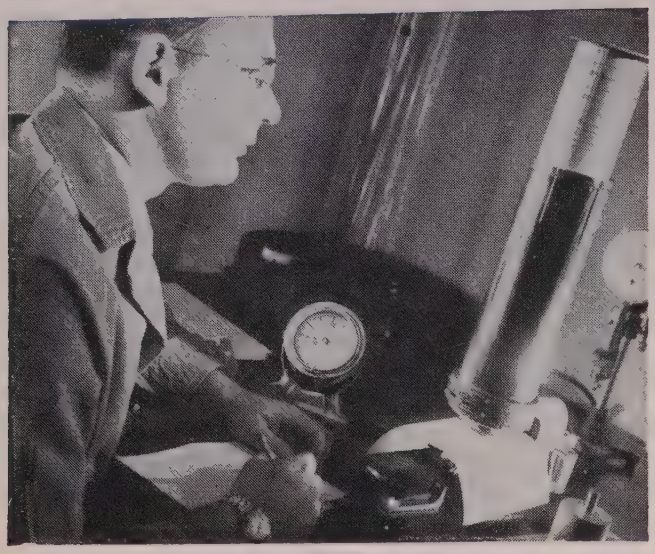


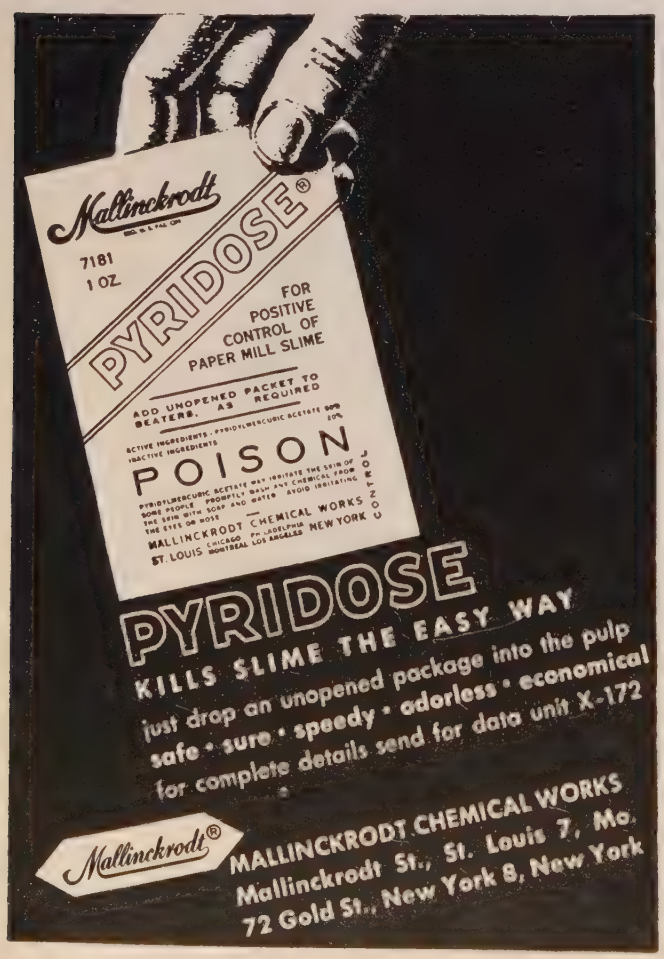
Photo, Courtesy J. M Huber Corporation

Single Instrument Measures Smoothness, Porosity and Softness of Paper

You just interchange the lower test plates in the GURLEY-HILL S-P-S Tester to convert it into an instrument for testing either smoothness, porosity or softness of any type of paper, by measuring a given air-leakage over or through the paper.

This 3-in-1 laboratory "assistant" is simple to operate, quick and accurate, and a real utility instrument where printing quality of paper must be reliably measured.

Bulletin No. 1400 describes the S-P-S Tester as well as other Gurley paper testing instruments. It's worth writing for today. W. & L. E. Gurley, Station Plaza & Fulton Sts., Troy, New York.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such that either set of embossing rollers can be used while bypassing the second set of rollers.

Each embossing line was engineered, and has been operated up to 800 f.p.m. with tension control being maintained between the embossing rollers and the drum polishing section.

Printing

Printing, as an industry, is full of paradoxes. It is a multibillion-dollar industry, but a small-business field. The largest printing firms, whose presses cover acres of floor space, handle only a small percentage of the total business. The Printing Industry of America calculates that it takes 900 of the largest printing plants to account for more than half of total sales. Modern rotary presses undreamed of only a hundred years ago work side by side with handicraft skills reminiscent of medieval and ancient methods. Presses that run at a thousand feet a minute use plates that take hundreds of man-hours to make.

There are three major printing methods today, all traditional—letterpress, lithography or offset, and gravure. Each of these three makes a different impression on a sheet of paper, and each requires a printing ink with appropriate characteristics.

Letterpress is the oldest of the three. In this method, raised or relief type is inked and pressed onto paper under heavy pressure, ranging as high as 1200 p.s.i. Letterpress halftone plates, etched into thousands of raised dots, print in the same way. Variations in the size of the dots produce fine gradations of tone. Letterpress inks are heatset for instant drying on high-speed presses. Heating units are incorporated into the press.

Lithography uses planographic plates—that is, plates with no raised or incised surfaces. Printing surfaces are greased to attract ink. Nonprinting surfaces have been washed with water, and repel ink. Because of the water involved in this process, lithographic inks are heavy-bodied.

Gravure makes use of sunken printing surfaces, which contain minute cross-hatched reservoirs for ink. Gravure halftone plates use dots varying in *depth*, not in size. Gradations of tone stem from the varying density of ink deposited by the tiny dots in the halftone plate. Gravure inks, therefore, have to be very fluid and free-flowing.—*Whitcomings*

Westinghouse

Enso-Gutzeit Osakeyhtio, one of Finland's largest paper manufacturers, has ordered electrical equipment from the Westinghouse Electric International Co. for installation in its paper mill at Kotka, located on the Gulf of Finland about 100 miles from Helsinki.

The order includes a 1250-hp. adjustable-voltage electric drive, two 15-hp. winder drive motors, and a number of helper drives. The new equipment will be used to power a light kraft papermaking machine which has an annual capacity of 45,000 metric tons.

The electric drive is the third unit of its kind which Enso-Gutzeit Oy. has ordered from Westinghouse in the past three years. One was placed in operation recently at the company's mill at Kaukopaa, on Lake Seimaa in southeastern Finland. Another is scheduled to begin operation at the Kotka mill in the Fall. All are designed to drive paper machines at a speed range of 200 to 2000 f.p.m.

The winder drive included in the order will feature a magnetic amplifier system which requires little or no maintenance and provides high amplification of current. Helper drives will range from 3 to 200 hp. Both main and helper drives will have Rototrol controls, which maintain motor speed accurately under all types of load changes.

The equipment on order will be manufactured by Westinghouse plants at East Pittsburgh, Pa., and Buffalo, N. Y. Delivery is expected to be made early in 1953.

Westinghouse has announced that it will build a multimillion dollar industrial and commercial lighting equipment

plant at Vicksburg, Miss. It will be the largest plant in the nation devoted exclusively to the manufacture of industrial incandescent fixtures. The plant should be ready for occupancy by early Fall of 1953.

HERCULES

Werner C. Brown has been appointed Assistant Director of Sales of the Cellulose Products Dept. of the Hercules Powder Co., Wilmington, Del. Mr. Brown will head up the sales of cellulose acetate, ethyl cellulose, plastic molding powder, as well as C M C (also known as cellulose gum). A. R. Olsen will succeed Mr. Brown as Manager of C M C Sales.

DU PONT

In July E. I. du Pont de Nemours & Co., Inc., celebrated its 150th anniversary at the site of the company's first mill on Brandywine Creek. During the past month the company distributed an attractive and unusually interesting book "Du Pont—The Autobiography of an American Enterprise," which traces the company's role in growth and development of the nation.

Following is a brief Du Pont chronology.

1802—Founded on Brandywine Creek near Wilmington, Del.
1804—First powder sold. First patent issued to company.
1857—New, cheaper blasting powder developed.
1880—Production of nitroglycerine and dynamite started.
1894—Manufacture of smokeless sporting powder begun.
1902—Eastern Laboratory built, one of first industrial research laboratories in U. S.
1903—Experimental Station established to diversify and expand company's business.
1904—First diversification with nitrocellulose for lacquers. Formal pension plan and organized safety program inaugurated.
1910–25—Entered fields of plastics, paints, dyes, rayon, cellophane, and other chemical products.
1927—Program of fundamental research launched.
1931—Neoprene announced, first successful general-purpose synthetic rubber.
1934—Laboratory of industrial toxicology, first of its kind in country, established.
1938—Nylon announced.
1940–45—Du Pont designed, built, and operated large number of war plants for government, including Hanford atomic energy plant.
1948—"Orlon" acrylic fiber and titanium metal production announced.
1950—At government request, undertook construction of Savannah River atomic energy plant. "Dacron" polyester fiber introduced.
1951—Major expansion of Experimental Station completed.
1952—"Mylar" polyester film announced.

WOLFERZ

E. C. Wolferz Alloy Equipment, Belleville, N. J., has issued a 4-page folder on "Alloy Equipment for the Pulp and Paper Industry." The folder gives some idea of the versatility of the company, which not only manufactures, but also designs simple and complex piping systems, hoppers, vats, tanks, cooking equipment, etc.

ARIES

R. S. Aries and Associates, New York, Chemical Engineers, have established a regional office at 211 Brightwood Place, San Antonio, Tex. Operations will be directed by Alden H. Waitt, former head of the Army Chemical Warfare Service.

ALLIS-CHALMERS

R. S. Stevenson has been elected Executive Vice-President of the Allis-Chalmers Mfg. Co., Milwaukee, Wis.

CYANAMID

The Boston office, laboratory, and warehouse of the American Cyanamid Co. is now located at 1055 Commonwealth Ave. N. A. Billings, Jr., R. O. Lindsey, and F. A. Strovink, TAPPI members, are now located at this address.

STALEY

A. E. Staley Mfg. Co. has established branch offices in

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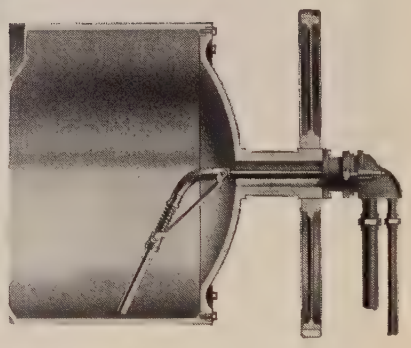
Reaction of ¾" Auto-Flex in 48" dia. dryer. Very low leverage.

Reaction of ¾" ordinary bent pipe. Syphon in 48" dia. dryer. High leverage.



for using Midwest Auto-Flex Syphons

Midwest Auto-Flex syphons have been on the market for years and many thousands are in service for two very excellent reasons—they hold their position—they wear indefinitely.

1. The spring and brace holds the end of the pipe at the proper distance from the bottom of the dryer. It cannot possibly take any other position — hence, proper water and air removal.

2. The cantilever leverage exerted is lower than with bent pipe syphons, only 170# vs 354#. It clears instead of dragging on the journal and rapidly wearing out.

Order a get acquainted dozen. Performance as stated guaranteed.

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For Facts About CUTTERS

For Paper Mills

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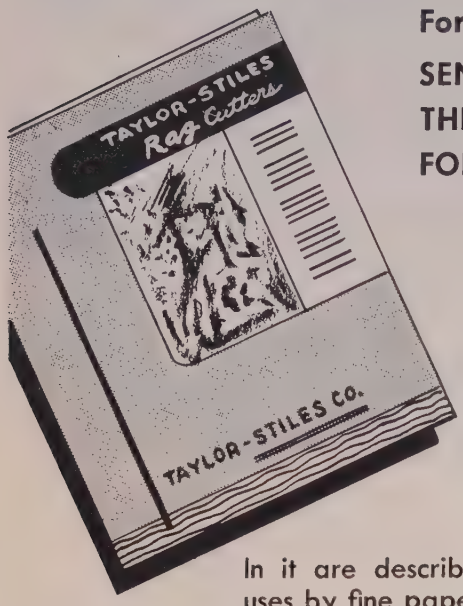

In it are described cutters for uses by fine paper mills, roofing and felt mills, and cigarette, blotting paper, boxboard, pulp, and strawboard mills. Also bale breakers.

TAYLOR, STILES & COMPANY

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MOTOR DRIVEN MODEL A TESTER. Especially designed for testing corrugated as well as other materials with bursting strengths above 200 pounds per square inch. Conforms to the test specifications of Rule 41 of the Consolidated Freight Classification No. 20. Special attachments available to quickly convert tester to perform flat crush tests or compression ring (edgewise) tests.

Send for booklet illustrating and describing the entire line of testers, and information on additional attachments.

B. F. PERKINS & SON, INC.

Holyoke, Massachusetts

Chicago, St. Louis, and Kansas City. This completes the company's program of establishing branch offices. Other offices are located at Boston, New York, Cleveland, Philadelphia, Atlanta, and San Francisco. N. K. Hammer is the manager of the new Chicago office. The Chicago staff consists of thirteen representatives who will cover the upper peninsula of Michigan, Wisconsin, northern Illinois, and northern Indiana.

General Electric

The General Electric Co., Schenectady, N. Y., has issued two bulletins: "Tachometer Kit for Production Supervisors for Recording and Controlling Production" (G E C-816) and "Differential-Voltage Indicator" (G E C-892).

Johns-Manville

Johns-Manville Corp. is expanding its industrial insulation plant at Watson, Calif. This plant serves the West Coast and Rocky Mountain states with transite asbestos-cement pipe.

American Resinous Chemicals

The American Resinous Chemicals Corp., Peabody, Mass., has issued a data sheet (A-43) covering "Resin Emulsions for Heat Seal and Grease Proofing." These emulsions are designed for heat bonding various combinations of papers, clothes, leathers, metal foils, plastic films, and other surfaces. They may also be used for heat seal end labels, bag closures, and similar applications.

Armco

A 25 by 38-in. illustrated wall chart has been issued by the Armco Steel Corp., Middletown, Ohio, for use by sheet metal departments. It pictures 12 operations in cutting and forming stainless steels. These include such practices as handling, proper protection, shearing, snipping, hand-sawing, forming in brake, and roll forming.

U. S.-Owned Patents

The U. S. Dept. of Commerce, Washington, D. C., has issued a 104-page publication "Government-Owned Inventions for Free Use" ($1.00). 2339 patents are listed, available to any manufacturer under nonexclusive, royalty-free license.

Sulphur

The most recent major brimstone deposit to come to light, and one which promises to prove the biggest sulphur development anywhere in the world in the past 20 years is at Garden Island Bay, La. The Texas Co. discovered the dome near the mouth of the Mississippi River while exploring for oil. Through a leasing arrangement, Freeport Sulphur Co. has obtained sulphur rights to the dome and is building a ten to fifteen million dollar plant having a production capacity of 500,000 long tons a year.

Foxboro

The Foxboro Co., Foxboro, Mass., has appointed W. H. T. Furry as Associate Director of its Training School staff. The school is now in its 17th year. The staff is under the direction of Malcolm B. Hall, Director, and Kenneth A. Bell, Associate Director. Training in process measurement and control is given to engineers and instrument maintenance men from practically every industrial field, including pulp and paper manufacture.

Becco

Charles A. Buerk, President of the Buffalo Electrochemical Co., Inc., has announced that arrangements have been completed by which the company has become a division of Food Machinery and Chemical Corp. Company policies and personnel remain unchanged. Relations with customers will remain no different from what they have been in the past.

Cowles

The Cowles Co., Inc., Cayuga, N. Y., has announced the licensing of the Black-Clawson Co., Inc., Hamilton, Ohio, to

manufacture and sell the Cowles Aquapulper, Beatapulper, and Classipulper. These machines will be manufactured by the Shartle Bros. Machine Co. Div. at Middletown, Ohio. Under the licensing agreement the name Shartle will replace Cowles. The licensing agreement was arranged, according to Edwin Cowles, President of the Cowles Co., to permit increased production and speedier delivery of these products. It will enable the Cowles Co. to devote more time to the development of new products.

EASTWOOD-NEALLEY

Vernon D. Knight has been appointed by the Eastwood-Nealley Corp., Belleville, N. J., to represent the company in its southern territory. He replaces Albert S. Landers who has returned to the industrial engineering field where he was formerly employed. Mr. Knight was formerly an Administrative Assistant of the International Paper Co., Southern Kraft Div. He resides at 312 S. Monterey St., Mobile, Ala.

MONSANTO

Monsanto Chemical Co., Plastic Div., Springfield, Mass., has issued a bulletin describing Lustrex X-700, a series of water-soluble, modified styrene polymer resins with a variety of applications in the paper industry.

ROHM AND HAAS

Rohm and Haas Co., Washington Square, Philadelphia 5, Pa., has issued a bulletin describing Uformite-711, a new wet-strength modified urea-formaldehyde resin in aqueous solution. A feature of Uformite-711 is its lack of sensitivity to the presence of residual bleaching agents and free chlorine which may be used as a slime-control agent.

E. D. JONES

E. D. Jones & Sons Co., Pittsfield, Mass., has issued a new bulletin (E D J-1035) descriptive of the Jones Fibremaster Jordan and Midget Jordan.

SPRAY NOZZLES

Binks Manufacturing Co., Industrial Nozzle Div., 3114 Carroll Ave., Chicago 12, Ill., has issued a 40-page bulletin (No. 5200) describing its wide line of spray nozzles for use on head boxes, filters, screens, wet machines, barking drums, etc.

CHICAGO TESTING LABORATORY

The Chicago Testing Laboratory, 536 Lake Shore Dr., Chicago, Ill., headed by Gene Abson, has announced the establishment of a Specialties Div. to be under the supervision of Arthur C. Dreshfield. This Division with its new laboratory will undertake problems relating to paper, paperboard, metal foils, plastic foils, foodstuffs packaging, and chemicals used in papermaking and converting operations. Routine testing and control and development problems will be within the scope of the laboratories activities.

PLANT MAINTENANCE

The next Plant Maintenance Show will be held in the Public Auditorium, Cleveland, Ohio, on Jan. 19–22, 1953.

LINK-BELT

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., has issued a 148-page Roller Chain Engineering Data Book (No. 2457). Detailed information covers the selection, installation, lubrication, and maintenance of roller chain for drives and conveyor, and sprocket wheels.

STEBBINS

At its July annual meeting the following changes were made in the organization of the Stebbins Engineering & Mfg. Co., Watertown, N. Y.: Carl F. Richter, who has been President for the past 17 years was elected Chairman of the Board of Directors; E. F. Tucker succeeds him as President; A. S. Quinn of Seattle is Vice-President; H. W. Duggan is Vice-

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★ COATING MACHINE

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The Type S is self-supporting . . . and from a cost standpoint it carries its own weight too. It stops misalignment cold because it shifts with the roll — slashes maintenance because it's completely packless and self-lubricating. It's the perfect answer for many jobs.

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IRON CASTINGS

International Nickel Co., 67 Wall St., New York 5, N. Y., has issued a 32-page booklet on Glossary of Terms for Producers and Users of Iron Castings. This booklet will be useful to designers, machinists, and purchasers of castings.

HERMANN

George A. Hermann has resigned as President of the Hermann Mfg. Co., Lancaster, Ohio, manufacturer of the Hermann Claflin Refiner and the pulp testing apparatus used in connection with the TAPPI sheet forming standard, to become Vice-President in Charge of Sales of the same company.

VULCAN

The Vulcan Copper & Supply Co. of Cincinnati, Ohio, manufacturers of chemical engineering equipment have opened an office in the new Chrysler Building East, at 161 E. 42nd St., New York, N. Y., to represent its Engineering, Manufacturing, and Construction Divs. V. D. Drummond, at present Manager of the Vulcan Engineering Div., will manage the New York office. Raphael Katzen succeeds Mr. Drummond as Manager of the Engineering Div.

MINNEAPOLIS-HONEYWELL

Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa., has issued an Index of Literature of the Industrial Div. and an interesting Data Book (15-14) "Instruments Accelerate Research."

OBITUARIES

Clarence P. Robinson

Clarence Paulin Robinson, Manufacturers' Representative, New York, N. Y., died in his sleep on June 12 at Mechanicville, N. Y.

Clarence P. Robinson

Mr. Robinson was born on March 20, 1884, at Salem, N. J. He entered the paper industry as an Accountant for the National Waterproofing Co., Camden, N. J. Two years later he joined the Cherry River Paper Co., Richwood, W. Va., as Purchasing Agent and Assistant to the Mill Superintendent. He remained at the mill for nine years and followed this with two years in the company's sales office in Philadelphia. During the next ten years he was a member of the pulp sales organization of the Borregaard Co. in New York.

Following this connection Mr. Robinson established his own business as a Manufacturers' Representative in New York. In this capacity he represented the Heppenstall Co., Kidder Press Co., Hanchett Manufacturing Co., and the American Shear Knife Co.

Mr. Robinson was buried at Boonton, N. J., on June 17. He is survived by his widow, Elizabeth, and a daughter, Katherine Ann.

Bertram A. Audley

Bertram A. Audley, Vice-President in Charge of Sales for the Lockport Felt Co., died at his home in Newfane, N. Y., on June 22, 1952 after an illness of several months.

Bertram A. Audley

Mr. Audley was 63 years of age. He entered the employ of the Lockport Felt Co. 32 years ago, starting as a Bookkeeper. In 1935 he was elected Director. He was promoted to Assistant Manager in 1942 and four years later became Assistant to the President. Since 1948 he has been Vice-President in Charge of Sales.

Surviving are his wife, Florence Underhill Audley, a daughter, Mrs. Colleen Audley Valery, and one grandchild.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Empire State

A joint meeting of Empire State TAPPI and the Niagara Branch of the Technical Section of CPPA was held at the General Brock Hotel, Niagara Falls, Ont., June 19–21, 1952. It was well attended, not only by members of the two respective sections, but by representatives from all over the United States and Canada. The total registration was 244 of which 201 attended the closing dinner and dance.

The technical program for the metting was divided into four panel discussions and covered the following subjects: "Wastepaper–Its Growing Importance to the Paper Industry"; "Mechanical Pulp—Its Expanding Applications in Paper Manufacture"; "Recent Trends in Pulp Bleaching Processes"; and "Quality Requirements by Paper Consumers."

Another feature of the meeting was the mill visits to twelve of the leading Canadian and United States mills. These were the Ontario Paper Co., Thorold, Ont.; Alliance Paper Mills, Merritton, Ont.; Provincial Paper Ltd., Thorold, Ont.; Beaver Wood Fiber Co., Thorold, Ont.; Interlake Tissue, St. Mills Co., Merritton, Ont.; Garden City Paper Mills Co., St. Catherines, Ont.; Kimberly Clark Corp., Niagara Falls, N. Y.; International Paper Co., North Tonawanda, N. Y.; International Paper Co., Niagara Falls, N. Y.; Certain-Teed Products Corp., Niagara Falls, N. Y.; United Board and Carton Corp. Lockport. N. Y.; and Robert Gair Co., Tonawanda, N. Y.

At the opening luncheon on Thursday, guests were privileged to hear K. P. Geohegan, National President of TAPPI. Mr. Geohegan spoke of the close cooperation between TAPPI and the Technical Section of the Canadian Pulp and Paper Association and stressed the value of a joint meeting such as this. He expressed the wish that more of these could be held

The final dinner on Saturday was attended by 200 people who heard D. W. Ambridge, President, Abitibi Power and Paper Co., address the group on the "Future of the Pulp and Paper Industry." Mr. Ambridge's inspiring talk pointed out the differences between the United States and Canadian paper production with the American emphasis on fine papers and board and the Canadian stress on newsprint. This has resulted in Canadian interest in mechanical pulping and American interest in chemical pulping. The two naturally complement each other.

R. G. Macdonald, TAPPI; J. S. Reichert, Du Pont Co.; D. W. Ambridge, Abitibi Power & Paper Co.

Wastepaper Panel

After a few words of welcome by W. Monsson, Hooker Electro-Chemical Co., Co-chairman of the Program Committee, J. J. Forsythe, International Paper Co., presided as moderator and introduced the first speaker, Earle Weaver, International Paper Co.

Wastepaper Statistics

Earle Weaver

STATISTICS are supposed to be a collection of facts on some subject with the expectation, I presume, that—on the basis of these facts—some action may result, or, at least, some conclusions may be drawn. We have plenty of facts regarding wastepaper, but the industry seems to be short of action based on those facts. The wastepaper industry has always been individualistic. Each packer or dealer runs his own business and is not inclined to throw in his lot with others. We need to learn more cooperation.

Well, let's look at some of the facts. In the first place, few people realize the size and the importance of the wastepaper industry. Wastepaper is usually thought of as something to be gotten rid of—to be put out with the ashes. People generally do not realize how important it is in the conservation of our forests. The more wastepaper is reclaimed, the less trees need to be cut down—or the more paper and board can be made using the same amount of wood. Statistics show that the rate of wood consumption in the South is some 17,000,000 cords per year greater than the present annual growth. We need wastepaper to make up some of this deficiency.

Last year, there were 9,000,000 tons of wastepaper used. This amounts to about one third of the raw material needed by the paper and paperboard industry. Just think of having one third of our needed raw material practically delivered for us at the consuming centers, no great amount of power nor chemicals needed for its conversion, coming year after year to the same places, more or less collected for us. We don't have to plant it or guard it against fire and destructive pests. We don't have to wait from 20 to 40 years for it to grow. The more paper and board made, the more raw material becomes available; the more we use, the more we have. When a tree is ground or cooked into pulp, it is finished—as a tree. Wastepaper is used over and over.

The records show that there is a growing appreciation of these advantages. Before World War II, the total wastepaper used rarely reached 4,000,000 tons in any one year. In 1939, the consumption was 4,366,200 tons; in 1941, 6,075,100; in 1947, 8,000,000; and in 1951, 9,000,000 tons. Thus, in 13 years, consumption has more than doubled. We think that the recent expansion of the paper industry has been phenomenal, but its rate of growth has not been so rapid as that of wastepaper. This indicates that wastepaper is more and more taking the place of pulp. We know that we cannot use wastepaper in all cases instead of pulp but, on the other hand, in printing papers, wastepaper has certain advantages over pulp.

How much can the use of wastepaper be increased? Of

EARLE WEAVER, International Paper Co., New York, N. Y.

course, the more paper and board are produced, the more wastepaper should become available. All paper cannot be reclaimed. Some is exported, some is retained in semipermanent or permanent books and records, some is produced in such forms that cannot be reused as carbon paper, polyethylene-coated papers, etc. But even with these unreclaimable papers (and we don't know what percentage of the total these are), there must still be room for considerable increase in the per cent of paper that it is practical to reclaim. In 1944, a war year, great effort was made to collect wastepaper. Much advertising appeared stressing its necessity for the war efforts, local drives were organized, the school children collected paper and brought it to the schools for delivery to the dealers, and last but not least, prices were high, making any labor expended very worth while. Even then, only 35.6% of all new paper and board that was used was actually collected for reuse. That percentage can certainly be bettered. After the war, with less emphasis on wastepaper, the per cent reclaimed fell to 28 to 30—about where it was before the war. In 1951, there was a little step-up due to the war effort, to almost 31%.

The present market situation in wastepaper is bleak. As is always the case, a heavy demand, with consequent high prices, has brought out an unprecedented supply, and then, at the high point of supply, business began to fall off and consumption began to slide. Now the main problem is not so much price, but where to find a taker.

The long pull outlook for wastepaper is good. The country needs to utilize its wastepaper to substitute for pulp—which means wood—as our forest resources are diminishing in the face of increasing need. Every ton of wastepaper used is roughly a cord and a third of wood saved. Thus, the wastepaper industry is making a necessary and vitally important contribution to the national economy. If the industry is to grow up to its responsibilities, one thing it must do—find some way to even out the peaks and valleys of supply and demand which now are at the bottom of most of its troubles. Until this problem is at least partially solved, the industry will be plagued with gambling and speculation not only as to price—but also as to quality.

Haskell Stovroff, Buffalo Waste Paper Co., Inc., spoke on the topic, "Collecting, Grading, and Sorting Wastepapers." The present-day oversupply of low-grade wastepaper and recent contamination problems caused by synthetic resin adhesives and other similar deleterious materials were discussed in this paper.

Collecting, Grading, and Sorting Wastepapers

Haskell Stovroff

While I know you gentlemen are primarily interested in pulp substitutes or high-grade paper stock, my subject covers the entire wastepaper industry.

The paperboard industry uses approximately 75% of the wastepaper generated by the trade, most of which is low-grade paper stock. The sources and methods of handling these two categories are entirely different. I will try to describe them to you.

Mixed paper, old corrugated containers, kraft wrapping, used kraft bags, and old records or files are collected from industrial concerns, department stores, and similar buildings. These items are collected by small one-truck collectors or by the trucks of large wastepaper packers. Old newspapers and magazines are collected primarily from private homes, apartment houses, and the like, very often by peddlers who collect all types of waste material and take their mixed loads to what is commonly called a junk shop. This shop will bale the newspaper and magazines, as well as the rags, metal, etc. These items are then sold to dealers specializing in each commodity.

Haskell Stovroff, Buffalo Waste Paper Co., Inc., Buffalo, N. Y.

Wastepaper Panel (Bottom Row, Left to Right): Earle Weaver, International Paper Co.; J. J. Forsythe, International Paper Co.; W. A. Logan, Provincial Paper, Ltd. Top Row, Left to Right: R. W. Hynes, Newton Falls Paper Mills; John Clouse, Oxford Miami Paper Co.; Haskell Stovroff, Buffalo Waste Paper Co.; Fred C. Goodwill, St. Regis Paper Co.; D. D. Uong, Fitchburg Paper Co.

Another source of paper stock, most of which is consumed by the paper industry, is the waste from printers, publishers, manufacturers of business forms, file folders, tabulating cards, envelope manufacturers, and book and magazine publishers. This is the source of a considerable tonnage, most of which has to be sorted and packed by a dealer specializing in this business. The box and bag manufacturers also produce a lot of cuttings which are used primarily by the board industry.

The wastepaper is brought to the paper stock packing plant in bags, crates, bundles, or small bales. It is then sorted into as many grades as practical and economically possible so that it can be used by mills to the best advantage, either for board mill filler or liner or by the paper mills as a pulp substitute. The sorted items are stored in bins until enough of each is available to make a bale. The material is then baled and stored until a truck or carload accumulates.

Our company employs girls who require from 6 months' to 1 year's experience in order to perform this sorting job properly. We pack 65 different grades of paper stock for use by mills of all types.

Wastepaper dealers are of all sizes but only the larger ones sort. It requires a large plant, conveyor belts, and heavy duty baling presses to perform this sorting and packing operation. Smaller dealers merely bale mixed paper, newspaper, old corrugated containers, and magazines. They usually sell their accumulations to the larger operators who deal in quantities of stock to be sorted as well as graded paper stock. These dealers always buy and sell for their own account as compared to acting as brokers or agents, similar to the setup in pulp.

It is most important that the packer have a complete knowledge of the requirements of the mill so as to supply the right grade for the proper purpose.

We try to assist our consumers in their use of paper stock by packing special grades for special purposes and by suggesting the use of new grades when we learn the grade of paper or board they are going to make. There is need for real understanding and cooperation between the dealer and the mill.

There are many problems facing the wastepaper industry today, most pressing of which is the terrible oversupply of low grades. In addition, reductions in prices of imported pulp and the increasing supply of domestic pulp of all grades are resulting in drastic price reductions in high-grade paper stock. This is particularly serious to the dealer who packs books, ledgers, and shavings of various types. He is being squeezed between reduced margins of profit and increasing costs of operation. The hysterical overbuying during the period immediately following the start of the Korean emergency has resulted in loss of running time on the part of the paperboard mills.

Since the wastepaper industry gradually attained a collection and handling organization to supply the industry with an unprecedented amount of tonnage, based on a 7-day week, the present loss of running time by these mills results in a serious oversupply of the low grades. Even price reductions resulting in a price level which makes it necessary to operate below cost, have failed to completely dry up the excess supply. There is not a great deal that the dealers can do to remedy their plight.

In many cities dealers are charging for the removal of wastepaper from office buildings and industrial concerns. If these charges amount to enough, they can pack the wastepaper and sell it at the current levels without losing money. The desire of the industry is that the dealers will buy and handle only that amount of tonnage which they can sell. However, the answer is not as simple as that.

During the Spring of the year, no matter what the price level, a huge supply of newspaper and other items comes on the market. This is the result of the efforts of service organizations, schools, and other groups who continue to collect, even though the revenue is practically nothing, so as to keep their organization functioning and in a position to handle the paper when the price is high. The great hope of the wastepaper industry is that the board mills will get enough business to run full in the near future. Many people feel this will come to pass as employment in most lines is high and people are buying goods at the retail level. Once the manufacturers and retailers adjust their inventories of folding cartons and containers, the board mills should receive more business and therefore, use enough paper stock to keep the wastepaper industry functioning on a more normal basis.

One of the most recent problems confronting the wastepaper dealer is the use of synthetic resin adhesives by the various converters of paper products. Magazine and book publishers, cup manufacturers, and other people have adopted the use of such adhesives in their manufacturing processes and in so doing have contaminated the wastepaper resulting from their operations so that it can no longer be used as heretofore. Paper stock items which formerly went into the manufacture of high-grade paper, now have to be used as filler in the manufacture of boxboard.

The problem is being attacked by paper mills, adhesive manufacturers, and all other interested parties. However, the dealer finds himself in the middle and is very often in a controversy with the concern he buys the waste from and the mill to which he sells it. As a result of this description of the wastepaper business, it is easy to see that it is a very interesting and confusing industry. At the present time, the dealers are fighting to stay in business but it is my belief that as long as the paper and board industry requires the use of the secondary fiber produced by the wastepaper dealers, they will always be available to perform their necessary function in the industry.

Nonfibrous Materials Present in Wastepapers and Their Reactions with Caustic Soda

D. D. Uong

The subject of my assignment is, "Nonfibrous Materials Present in Wastepapers and Their Reactions with Caustic Soda; Elimination of Tacky Spots in Papers Produced from the Recovered Stock." It is a very broad and comprehensive subject which can easily be divided into two parts, namely, (1) nonfibrous materials present in wastepapers and their reactions with caustic soda and, (2) elimination of tacky spots in papers produced from the recovered stock. There is, of course, a great deal of interrelationship between the two parts.

Nonfibrous materials present in wastepapers may range from coins, jewelry, rubber boots, cigar stubs, tin cans to adhesives, white and colored pigments, and coatings of varnish, lacquer, and various kinds of synthetic resins. Fortunately some of the aforementioned foreign materials can readily be eliminated by careful sorting so that they seldom have a chance to go through the deinking operation. If any of the large, heavy, and unbreakable foreign materials should get by the sorting operation they could readily be separated by settling and screening.

D. D. Uong, Fitchburg Paper Co., Fitchburg, Mass.

Left to Right: Ken P. Geohegan, Howard Paper Mills; J. S. Reichert, Du Pont Co.; J. N. Stephenson, Pulp & Paper Magazine of Canada

The kind of nonfibrous materials present in wastepapers which cause trouble in the deinking operation are the ones difficult to detect and costly to remove. They may be present in the form of adhesives, ink and coating binders, and coating and laminating films. They are the principal causes for the tacky spots in papers.

Adhesives containing natural and synthetic latices may be found in splicing pasters, padding cement, magazine binding, thermosetting adhesives and coatings, and the tacky household industrial tapes. Possibly some of the latices by themselves alone may not be too troublesome; but when they go through the deinking operation wherein they are brought together with all the materials in the wastepaper in the presence of hot alkaline solution, they somehow transform into trouble-making agglomerates. The worst and the most objectionable of the trouble-making agglomerates, are the sticky colored specks which are not heavy enough to settle out or to be thrown out by centrifugal separation and coarse enough to be removed by screening, but large enough to spoil the appearance of paper and to cause trouble in the usage of paper by sticking two sheets together.

Specifically here are some of the most objectionable nonfibrous materials which have been encountered in the deinking operation:

1. Paster adhesive containing natural and synthetic latices.
2. Domestic and industrial adhesive tapes made of natural and synthetic rubber base.
3. Delayed action heat-sealing labels.
4. Binder cements for binding pads and magazines containing synthetic and natural rubbers.
5. Adhesives having polystyrene and polyvinyl acetate as part of their ingredients.
6. Ink binders made of gilsonite or any synthetic resin that is not soluble or dispersible in hot alkaline solution.

The elimination of the colored, tacky spots in paper is not a simple problem. It has cost the paper mills a good sum of money in the past few years. This sum of money has been estimated to be as great as reaching seven figures in a year. In addition it has been a real source of headache to the papermakers and to the users of paper.

The necessity of solving this problem has been well recognized by practically all the paper mills having a deinking plant. For quite some time, especially since last Fall, a great deal of time and thought have been spent in trying to solve this problem by paper mills and wastepaper dealers. Obviously the best way to eliminate this kind of trouble is to

Registration Desk: Miss Hartlieb, Alliance Paper Mills, Ltd.; Gordon K. Storin, Niagara Alkali Co.; George Norton, George Irish Paper Co.; Joe Delaney, Interlake Tissue Mills; Paul Haggerty, George LaMonte & Sons

avoid the use of the kinds of wastepapers that would cause this trouble. If once they get into the deinking system, appropriate means must be found to get rid of them, otherwise, it will not only cause headaches in the papermaking operation but will result in costly complaints from customers.

In the deinking discussion which took place in New York last February, James A. Wise of the Kalamazoo Paper Co. and W. A. Kirkpatrick of the Allied Paper Mills very ably and explicitly presented a paper on the subject, "Deinking Mills Dilemma." In driving their point home they gave an incident in which one mill had encountered three times trouble with a certain brand of bread wrap end seals which contained a trouble-making adhesive. Each encounter cost that mill approximately $15,000. They also pointed out clearly just what the wastepaper means to the paper industry and the consumers of paper, as well as to the dwindling forest reserves.

Realizing the importance of this problem to the paper industry and to the economy of the nation, the Materials Committee of the American Paper and Pulp Assn. has met twice recently in an attempt to find ways and means to solve it. In their first meeting which took place on the 15th of May the committee, after a lengthy discussion, came to a conclusion that the solution of the problem could be best approached from two angles, namely, the technical and the educational, and that these programs should be handled by a central industry-wide organization. The first meeting was attended not only by the members of the Materials Committee but by C. S. Baker, Director of the Eastern Conservation Committee, W. S. Edwards, Chief of the Wastepaper Section of Pulp and Paper and Board Div., National Production Authority, and M. D. Dickson and Paul J. White of the National Assn. of Wastepaper Dealers.

In their second meeting which took place on the 4th of June, William Crawford, President of the National Assn. of Magazine Publishers, was present. Mr. Crawford's interest in solving this problem appeared to be as great as that of any of the paper mill representatives present. He expressed willingness to do everything he could to present the problem to the National Assn. of Magazine Publishers, and he hoped that they would do their part to help us solve the problem by refraining from the use of any material in their operation that would prevent the reclamation of fiber from the wastepaper.

The Materials Committee of the American Paper and Pulp Assn. felt that the best way to keep objectionable materials out of the wastepaper is to use an educational method of approach. In carrying out the educational program the committee felt that it would be desirable to have a close cooperation with the board mills, the publishers, the ink manufacturers, the adhesive manufacturers, and all such parties as may have an interest in this problem. The proposed central organization will serve as a clearing house to gather such data and information concerning the use of any new and unknown material that may be introduced into the wastepaper by the converter or the consumer of paper, and distribute them to all the participating parties, thereby giving them enough advance warning so that they may be able to do something to avoid trouble in deinking.

Once the trouble-making material gets into the deinking operation unnoticed, the problem becomes technical. The material should then be identified as to what it is. After finding out its identity, ways and means must then be found to get rid of it.

If a trouble-making material is so difficult to eliminate that it is beyond the ability and facilities of the wastepaper packer and the paper mill to cope with the problem, a joint research project may then be sponsored by a part of or the entire membership of the proposed central organization. The benefit of such a joint research program will naturally go only to those parties participating in the project.

The following are some of the methods which have been tried with varying degrees of success in removing tacky spots: screening, settling, flotation, centrifugal separation, dissolving, and dispersing. With the possible exception of settling and screening, none of these methods is too simple. Many of them are prohibitively costly. The cost may range from $10 to more than $100 per ton of wastepaper processed.

It has been my fortune to have attended both of those two Materials Committee meetings of the American Paper and Pulp Assn. I was very favorably impressed by the amount of interest shown by all those who were present at the meetings. I am happy to tell you that the Executive Committee and the Board of Governors of the American Paper and Pulp Assn. are considering a draft submitted by the Materials Committee of the Association that the mechanics of working out the program be set up by the American Paper and Pulp Assn. in conjunction with an Operating Committee which will consist of:

1. Chairman and one or more members of the Materials Committee plus a technical man from the pulp and paper industry.
2. One or more representatives from the wastepaper packers, preferably from the National Assn. of Wastepaper Dealers.
3. One or more representatives of the paperboard industry.
4. One or more representatives from the National Assn. of Magazine Publishers.
5. A representative from the adhesive manufacturers.
6. A representative from the ink manufacturers.

While I cannot forecast the decision of the Executive Committee and the Board of Governors regarding the draft submitted by the Materials Committee, I have good reason to feel optimistic concerning the possibility of forming a central organization which appears to so many of us to be the best, the simplest, and the most economical way to solve the problem of getting rid of dirty and tacky spots in papers.

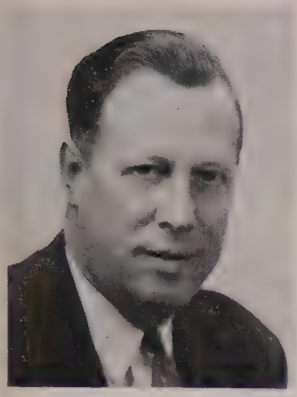
Processes for the Recovery of Ledger Stock and Other Wastepaper for Use in Paper Manufacturing

R. W. Hynes

Removing the ink from wastepaper, regardless of type, such as ledger, magazine, mixed paper, etc., presents a problem that can be considered in two phases: chemical and mechanical. The amount of such equipment is entirely dependent on how thorough a deinking job is necessary and also on the quality of wastepaper used. The equipment for handling sodium peroxide in a deinking process is covered in another paper; therefore, no need for coverage here.

In the case of caustic soda, which is probably the most commonly used deinking agent, only a large storage tank and a measuring tank are necessary to the operation.

R. W. Hynes, Newton Falls Paper Mills, Newton Falls, N. Y.



W. H. Monsson, Hooker Electrochemical Co.

H. P. Bailey, International Paper Co.

The mechanical side of the picture, which I believe is fully 97% of the problem, can be divided into six separate and essential types of equipment:

1. Hot water facilities.
2. Defibering equipment.
3. Cleaning and screening equipment.
4. Washing equipment.
5. Bleaching and chest capacities to handle both black and bleached stock.
6. Recovery of chemicals.

The equipment, as listed, is usually used in the same order. In other words, the stock flow sheet.

In order to do the best recovery job possible, it is essential to have great quantities of hot water. On types of paper entirely free of groundwood, we have found that cooking temperatures from 160 to 190° are very desirable. Facilities for heating water to that temperature, prior to its addition to the defibering process, are a great advantage both quality-wise and production-wise. In our plant we enjoy the ideal facility, which is an abandoned sulphite digester. All of the hot water from the various mill traps, exhaust steam from the machine turbines, etc., is collected in the digesters. Part of the heat recovered by Briner economizers over the machines is used for heating hot water which is also accumulated in the digester. Whatever additional steam that is needed is supplied by direct high-pressure steam from the boilers.

Typical and very desirable defibering equipment can be listed as hydrapulpers, dynopulpers, E. D. Jones pulpmasters, Lannoye pulpers, and/or any other high-density unit. Supplementing defibering equipment can be hydrafiners, dynofiners, jordans, high-pressure jet systems, pump-circulated open tank cookers, closed digester type, etc.

The cleaning and screening operation is accomplished very satisfactorily by various riffler arrangements, various types of flat screens, vortraps, dirtec units, classifiners, etc.

Proper washing of the fibers can be accomplished by vacuum washers, the Lancaster or decker type or the inclined screen type. The amount of washing equipment necessary is determined by the brightness of pulp desired, consistent with the type of wastepaper used.

Bleaching can be accomplished by the usual pulp bleaching units or by continuous circulation in a regular paddle-agitated chest.

Chemical recovery units are being developed and are being put into operation by mills due to the increasing pressure on stream pollution control.

The following outline of procedure for obtaining optimum results in color, cleanliness, and strength of fiber is one now in use in many plants, ours included.

Ledgers, both white and colored or their equivalent of a no. 1 quality, are unloaded from the cars with fork lift trucks and transferred into hydrapulpers after the pulpers have been filled with proper quantities of 160°-water to which has been added the average amount of 3% caustic soda. The batch is then brought up to 190° temperature in a matter of 30 min. The stock, at this point, has been defibered sufficiently to be transferred to an open cook chest to which we have coupled a dynofiner. Average cooking cycle is 2 hr. The pulp is then transferred into a black stock chest from which it is pumped to a battery of flat screens and then through a battery of dirtec units. From the screening unit we flow to a vaccum washer of the Improved Paper Machinery and Oliver filter type, then through four Lancaster-type washers. Stock is then transferred through a consistency regulator, where 2% bleach is added, and passes into a paddle-agitated bleach chest. Temperature is regulated at 125°. Bleaching cycle average is 2 hr. and average brightness, 72 G.E., will be obtained. Stock is then pumped over another Lancaster-type washer to the beater room storage chest.

Four men, including the foreman, operate the plant on each 8-hr. shift. Capacity of the plant is 70 tons.

Process for the Recovery of Wastepapers with Significant Groundwood Content

John L. Clouse, Sr.

Although the practice of reclaiming previously used fibers dates back almost 200 years and even though commercial deinking was practiced 40 years ago in the Kalamazoo area, nevertheless, the problem of reclaiming groundwood fibers has been largely side-stepped, up until the past few years.

Long ago, it was recognized that groundwood wastepapers, being essentially wood chips, came back to the deinking plant in a faded, dark yellow condition and suffered further loss of color when subjected to the high chemical concentrations, high temperatures, and long cooking periods of the standard reclaiming systems. Fortunately, in the past, groundwood usage was largely confined to papers which could be separated rather easily from the better grades of wastepaper containing only chemical fibers. Old magazines and ledger stocks were plentiful and cheap and essentially groundwood free, thus the problem of reclaiming groundwood could easily be side-stepped.

In the course of the last decade, however, a drastic change has taken place in the industry with the rapid growth of machine-coated papers for use in magazines. Since the base stock for most of these papers contains large amounts of groundwood, it is no longer possible to obtain enough groundwood-free wastepapers to supply the demands of existing deinking plants. Gradually, it has become obvious that each individual plant must choose between the following courses of action:

1. Compete for the small supply of groundwood-free wastepapers and be forced into high stock costs.
2. Find methods for using papers containing groundwood (i.e., methods enabling reuse of such stock in relatively good quality papers).
3. Cease deinking operations.

It is to the credit of the industry that most have found methods for using greater or lesser amounts of groundwood. A few continue to use groundwood-free stock, but we know of none which has decided to shut down. However because of the high cost and scarcity of groundwood-free papers, some of the smaller, marginal plants are strongly considering dropping deinking operations, they are further swayed in this thinking by the current stream pollution abatement pressure.

Generally speaking, those using groundwood content stocks comprise the bulk of the industry and are mostly large users who plan to continue in the field, meeting the demands of stock changes that are taking place. Our discussion today centers around this group.

John L. Clouse, Sr., Oxford Miami Paper Co., Carrollton, Ohio.

All members of this group have made some concessions to existing facts concerning the widespread usage of groundwood. The steps taken have been influenced by the grades of paper in which the finished product is to be used and by the fact that the severity of the problem is in almost direct proportion to the quantity of groundwood contained in the stock being processed. That is, the problem does not become too severe until the percentage of groundwood reaches about 8 to 10% of the total fiber present but above that point the reclaiming method used is largely dictated by the quantity present.

Thus the members of this group tend to differ widely in the amounts of groundwood they consider acceptable for their particular plant. Their thinking on this point is further influenced by their general ideas concerning the best methods of deinking. Roughly there are two schools of thought in approaching the problem:

1. Purify the groundwood until it resembles chemical fiber stock in many respects.
2. Treat the groundwood as gently as possible while accomplishing deinking.

Few processors subscribe to the former idea, but nevertheless it should be mentioned, even though briefly. Since the exact processes have been shrouded in a certain degree of secrecy, we must rely largely on conjecture and rumor as the basis for such discussion.

Since cooking of wood is really involved, it would seem necessary to use rather large amounts of effective chemicals and practice some method of reclaiming such chemicals. The cooking must definitely be followed by multiple-stage bleaching. The entire process requires extensive equipment and involves high chemical costs and large processing shrinkages. This method would seem to be suitable only for mills requiring large quantities of short-fibered stock and having no assured, reasonably priced source of same or mills having an exceedingly abundant local supply of cheap raw material in the form of overissues or equivalent.

Few in the industry feel impelled to go this far in solving the problem, but more conservative approaches are rather widely practiced. A study of the recent TAPPI questionnaire seems to indicate that mills producing about one third of the total tonnage are giving the problem special attention by using special chemicals for cooking. Others have modified their cooking methods to be in line with common knowledge as to the conditions most suitable for deinking groundwood; these factors involve time, temperature, and chemical concentration and are based on the premise that excessive amounts of any or all lead to undesirable color.

Literally hundreds of special cooking concoctions have been compounded and tried. The more successful ones deserve to be mentioned.

One of the earliest approaches was the use of sodium hydroxide together with sodium silicate. The former was used in the smallest quantity possible, but the latter was used in substantial amounts because it does not yellow groundwood and is a good dispersing agent.

Formulations built around sodium carbonate have had a degree of popularity. Generally speaking, such formulations have contained a very large number of different chemicals and have usually contained one or more of the multitudinous variety of soaps that have been tried in deinking processes.

Some claim great success with a combination of silicates and wetting agents, but in my own experience, these are effective only with the more readily dispersed inks.

Most of the successful efforts in the field have been based on the well-known fact that sodium peroxide is a good bleaching agent for groundwood; not only has it proved successful in this application but also it is a good deinking agent and was used for this purpose more than 30 years ago. Some use sodium peroxide by itself, but more often it is used as the key chemical in special formulations. These special formulations

Paul L. Haggerty, George LaMonte & Sons; James Gabler, Fleetwood Chemical Co.; Ralph Kumler, American Cyanamid Co.; Frank L. Bailey, Cameron Machine Co.

are multitudinous; some are carefully guarded secrets and others are patented. However, there are certain chemicals which have been openly favored as additives. Most commonly used is sodium silicate for the reasons mentioned previously. Sodium hydroxide also has received favorable notice when used in small quantities. With these it is not too unusual to find small amounts of synthetic detergents or wetting agents. Each plant seems to vary the ingredients to suit their particular problem.

Extensive experimental work has been done in this deinking field and undoubtedly thousands of combinations of chemicals have been tried. Still, in the end, the field has narrowed down to the relatively few chemicals mentioned above and of these, sodium peroxide is the outstanding.

In addition to the deinking problems presented by groundwood, there is also a bleaching problem which is quite acute. When the percentage of groundwood reaches 8 to 10% of the total fiber present it becomes extremely difficult to exceed 70 brightness; chlorine consumption rises rapidly, stock degradation becomes a factor and therefore, the economics of single-stage versus multiple-stage should be examined carefully. A number of plants have gone to three-stage processes in which the three stages are chlorination-caustic extraction-hypochlorite. Other plants are working on the problem as they wait and hope for a cheaper solution to the problem.

Although extensive work has been done with the peroxides in bleaching, still they appear not to have solved the problem. What success has been achieved with them has involved multiple-stage processes which also use hypochlorite. Probably this result should have been anticipated in view of the fact that groundwood papers often also contain unbleached chemical pulps which are not effectively bleached with peroxide. In any case, at this stage, the peroxides have complicated the bleaching problem rather than simplified it.

In conclusion, it must be remembered that with groundwood we are dealing with fiber bundles just as they came from the tree. Therefore, there is little real hope of producing an outstanding product by methods other than those which successfully do the same with a tree. Thus we are led to assume that the field is still wide open for experimentation and improvement.

Anyone who has been associated with deinking over the years cannot help having been impressed by the multitude of secret nostrums offered the trade with glowing claims. A few drops or ounces of such concoctions are purportedly capable of turning the lowest grade groundwood magazines into a stock approaching virgin pulp in cleanliness and brightness and at a price to tickle the larceny in our souls.

This is very natural where so many are aiming for this ideal and hoping to be the one to find the magic combination. But the magic combination has yet to be brought forth and progress has been slow and uncertain with many diverse opinions and wrecked hopes strewn along the way.

With all the progress that has been made to date, the paper world still awaits a better and cheaper solution to the problem.

In "Handling of High Wet-Strength Papers in the Wastepaper Recovery Process," W. A. Logan, Provincial Paper Ltd., reading a paper prepared by S. G. Stapley, Provincial Paper Ltd., Georgetown, Ont., described the recovery of such high wet-strength papers as blueprint and chart papers by means of inorganic acids and high temperatures. The high brightness and strength of the recovered fiber are most desirable features of this process.

The final paper on the Wastepaper Panel was entitled, "An Application of Economies in Heat and Chemical Usage in a Deinking Operation," and was delivered by F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich.

An Application of Economies in Heat and Chemical Usage in a Deinking Operation

F. C. Goodwell

A SURVEY of the literature on deinking of wastepaper readily reveals that the usage of steam and chemicals in this process has been the subject of considerable study. It was also recognized that economies in these two items were not only desirable but could be effected.

For a number of reasons, but principally in the interests of reducing costs, the St. Regis Paper Co. decided to put into practice some of these economies in the deinking plant of its Kalamazoo mill.

The first step was the installation of an 8 by 16-ft. Oliver vacuum washer between the "cooked stock" storage tank and screening section of the system. At the beginning, the water from the "cloudy" port of the washer was passed through heat exchangers to warm up the water for use in the breaker beater. However, the extracted materials in the waste water coated the heat exchanger tubes and rapidly dropped the efficiency and in a short time plugged the equipment completely. This necessitated frequent shutdowns.

The next step was to apply a recommendation made in an article* published in the *Paper Trade Journal* in 1947. The article was a report of a very thorough study of some of the possible economies in deinking operations by Bailey and Nadelman. The recommendation was the direct reuse of the washer effluent in the pulper. Experiments confirmed the laboratory findings of Bailey and Nadelman that such direct reuse did not have an adverse effect on brightness of the deinked stock, and this was established as standard practice.

The return of the washer effluent directly to the breaker beater not only eliminated the heat exchanger problem but made a maximum recovery of heat possible. While metering of steam in the deinking plant does not permit the pin-pointing of consumption in various sections of the operation, the difference in total consumption with and without the vacuum washer in service indicates the savings realized from reuse of the washer effluent. The saving is in the neighborhood of 5000 lb. of steam per ton of finished pulp. The average steam consumption in the deinking mill for the entire year of 1951, including heating and bleaching requirements, was 12,300 lb. per ton of finished pulp. Direct reuse of the washer effluent also made it possible to realize savings in chemicals because of the residual alkali in the effluent.

The method of deinking at this plant makes use of sodium peroxide and sodium silicate. In developing the process it was discovered that a certain optimum amount of peroxide was essential but experimentation demonstrated that a cut of 20% could safely be made in the silicate when the washer effluent was returned. The practices of direct reuse of vacuum washer effluent and reduction of amounts of fresh alkali have now been standard for over two years and with entirely satisfactory results.

The ribs of the washer drum do fill up at an undesirably fast rate which in turn requires removal of the wire cover and hand cleaning. At the time the washer was installed it was the only one that would be available in a reasonable length of time and though the drum was of wood construction and recognized as far from the most desirable material for the conditions under which it must operate, it was necessary to make the best of the situation. And so it was installed. A rubber-covered metal drum would permit the use of acid for keeping the ribs clean as well as not being affected by the hot alkaline water as is the wood. Also, less frequent wire cover removals would make the use of stainless steel covers worth while and so lessen this cost item.

It is entirely possible that with refinements, savings in addition to those indicated here could be realized. As an example, the maximum possible reduction in alkali usage has not been determined but, as Bailey and Nadelman pointed out in their report, the consumption of alkali varies and changes take place in the chemical constituents of the liquor. The choice would seem to lie, therefore, between application of close technical control and the use of a sufficient excess of alkali to assure having an adequate amount present at all times.

It is believed that the experiences related here substantiate ideas of previous investigators and demonstrate that sizable economies in steam and chemicals can be effected.

Following presentation of these papers, a question-and-answer discussion was held to cover points introduced and raised by the speakers.

Mechanical Pulp Panel

In the afternoon, the Mechanical Pulp Panel was presided over by Lyman A. Beeman, Finch Pruyn & Co., Glens Falls, N. Y., who introduced the opening speaker, Lloyd T. Bradley, Beaver Wood Fiber Co. In his paper, "Statistics on the Production and Applications of Groundwood," Mr. Bradley traced the growth of the groundwood industry in the past 20 years and commented on future trends.

Recent Improvements in the Production of Groundwood for Newsprint Manufacture

Morris R. Jones

THE recent trend in the manufacture of newsprint has been for higher paper machine speeds along with better sheet formation. In terms of groundwood this means more pulp of slower freeness and more uniform quality.

Unfortunately, high pulpwood cost, brought about by more expensive labor and longer transport, have forced the manufacturers into using more accessible wood of poorer quality for papermaking. To sum up, the groundwood mills have been called upon to manufacture a superior product with an inferior raw material. This paper outlines some of the measures taken to accomplish this task.

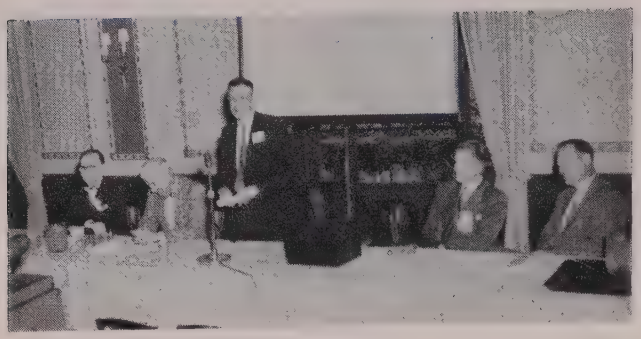
The species of wood now economically available for newsprint in the East include spruce, balsam, pine, and poplar. The latter two are not considered good pulpwood for newsprint but, as previously stated, are being used because of the proximity of supply to the mills.

Most mills using these woods are keeping very close control over the quantity used. This is done by stockpiling the different species separately and by running only these woods

F. C. GOODWELL, St. Regis Paper Co., Kalamazoo, Mich.

* Bailey, H. C., Nadelman, A. H., *Paper Trade J.* 125, No. 2 (July 10, 1947).

MORRIS R. JONES, The Ontario Paper Co., Ltd., Thorold, Ont.



Second Panel Group—Mechanical Pulping Panel (Left to Right): John McGovern, Forest Products Laboratories; Lloyd Bradley, Beaver Wood Fibre Board Co.; Lyman Beeman, Finch, Pruyn & Co.; Morris Jones, Alliance Paper Mills, Ltd.; R. J. Auchter, Kimberly-Clark Corp.

on certain grinders. In this way, a pulpstone which has a burr impression fit for low-density balsam is not suddenly called upon to grind high-density spruce with a consequent drop in production and possibly quality.

Improvements to the grinders have, in the main, been divided into two classes which are: (a) increased size and (b) more continuous load.

There has been a general trend toward larger and more liberally designed grinders. Greater strength allows higher loads to be carried and there is a large increase in the stonewood contact area. Old type pocket grinders, which gave 7.5 sq. ft. of wood contact area, have now been superseded by various types exceeding 25 sq. ft. of stonewood contact but which take up hardly as much floor space as two of the old style grinders. New designs allow loads of 125 to 150 hp. per sq. ft. of contact whereas old style machines carried about 75 hp. per sq. ft.

Grinding efficiency has been increased by more continuous application of load. Faster load response by electronic actuated devices on both the hydraulic and ring-type grinders has resulted in definite improvements.

A more thorough knowledge of the composition of artificial pulpstones by the operators, coupled with many improvements in design by the manufacturers, has resulted in benefit to both pulp quality and quantity. Still more information on pulpstone manufacture is sought by the operators who are asking for narrower ranges in hardness designation. It is felt that the hardness factor is as important as the grit size and combination. Interest is great in the pulpstone containing but one grit size. At this time, however, these are not operating in sufficient quantity to forecast their usefulness. Other improvements by the manufacturers include changes in bonding material, segment anchor bolts, and better jointing compounds.

Controlled penetration of the sharpening burr into the pulpstone is widely used. Although not foolproof by any means, this is very helpful. It is safe to say that, given a pulpstone of proper construction for the job on hand, well-controlled burring will cause it to produce pulp within very narrow quality limits for 75% of its operating time. In short, the old-fashioned "dulling cycle," represented by an almost diagonal freeness line from sharp to dull, is becoming more and more a horizontal straight line. Other operators are trying a controlled burring cycle with varying results. In this the main difficulty is the wood variation from day to day. Not only does this include differences in wood species but also moisture, density, and amount of seasoning, which all play their part.

One innovation of note has been made in the coarse screening system. This is the vibrating flat screen. Advantages of this machine include low maintenance cost, high capacity per square foot of floor space, and clean screening.

Pulp consistencies on the fine screening system have, on the whole, been increased. This is possibly due to improved centrifugal screen designs. Lower power per ton of product is general, although this is not a critical figure.

For normal refining practice, disk-type machines appear to have taken the lead. New designs in the plates for these refiners are available for specific jobs and merit close study by the operators to ensure the best output. The use of abrasive refiner plates is still in the laboratory stage and appears to present many difficulties. Considerable work has been done on low consistency (3 to 4%) refining, with excellent results. The high price of wood for most mills makes it imperative that they use all available fiber in the newsprint sheet. It would appear that the refining of coarse screen waste into usable fiber should be one of the operators' primary studies.

The groundwood mill which has taken full advantage of the foregoing advances, incorporated with present-day statistical control methods, has met and is fulfilling the demand for more pulp at a higher quality level.

Trends in the Use of Groundwood for the Production of Magazine Book, Catalog, Directory and Allied Papers

R. J. Auchter

Groundwood or mechanical pulp has at various times in its history been referred to as the "Cinderella pulp," "the oldest yet the newest pulp," and similar expressions to denote the varied interest with changes in demands for paper grades. It appears that we are again approaching a cycle where demands for groundwood will decrease to some degree. It is expected and there are positive examples that the industry as a whole will again develop new uses and new grades to offset this loss and even provide outlet for greater quantities of groundwood than evidenced in its history to date.

The pulp and paper industry has just gone through a period of modernization and expansion never before experienced. In this program, groundwood demands were raised to a new high level. Groundwood-producing capacities can readily meet these demands and in certain areas can provide additional tonnages to reach a new plateau.

The new design high-speed paper machines and related converting equipment such as printing presses have placed great emphasis on developing improved runnability properties into present groundwood paper grades. Since runnability is directly related to strength, the pulp furnish is immediately altered to provide this new requirement. Generally, this will result in the reduction of the groundwood content and replacement with long or chemical fiber. Marginal profitability on some of the present large groundwood-consuming grades will no doubt also reflect in a reduction in groundwood demand by partial or complete elimination of these grades.

To maintain present demand rates and counteract the above apparent trends, the industry will be required to look to the development of new grades and to the introduction of groundwood into some established grades. This latter is possible where groundwood pulp producers expand from their present grades into established grades where for the most part groundwood was not used because the manufacturers did not have groundwood-producing facilities. Market research and product development people are in effect very optimistic that the over-all importance of groundwood in the paper industry will not be lost in the period ahead.

To maintain or improve the present level of groundwood demands it is desirable to reconsider the properties of groundwood and the production methods. The advantages and disadvantages of groundwood pulp have been clearly defined. Concern over the former should be limited to point that we do not lose sight of its possible uses where its properties are

R. J. Auchter, Kimberly Clark Corp., Niagara Falls, N. Y.

advantageous. It is in the latter category that our active interest is required.

The mechanical pulping process was developed into its present status because of its important cost advantage. The reasons for this economic advantage are too well known for further expression here except for one related and very important point. The dwindling wood sources require that the pulp and paper industry seriously plan wood utilization programs to assure a continuing wood supply. Greater usage of mechanical pulp is seen as one of the important factors to reach this goal.

The use of groundwood pulp in papers to date has developed far beyond its original and basic economic advantage. It now provides opacity and printability characteristics previously found only in alkaline cooked hardwood pulps. The secondary reactions responsible for these results include the effects on formation, on the retention of mineral filler, on development of sheet stability and smoothness, and on the factor of cushion or resilience. It is reasonable to expect that further intensive study and development will lead to improved groundwood properties and result in better printing papers.

The disadvantages which result in the limitations on the expanding use of groundwood include poor strength, low color or brightness, poor cleanliness, and poor permanence. In the order of importance, the poor strength far outreaches the others and thus will require intensive study. In fact with regard to color and cleanliness, bleaching techniques and cleaning devices, respectively, have reached the point where these items can be taken off the list of disadvantages. Poor permanence is inherent and chances for significant improvement here are not good but this is not considered critical because the paper grades using groundwood do not require a high degree of permanence.

The foregoing concludes that the prime objective of the industry is to establish methods to produce and provide for the paper mill a groundwood pulp which is significantly stronger but retaining its present advantageous properties. In a competitive market, some degree of bleaching will become necessary. This will provide some measure of strength increase but at a sacrifice in opacity. Production methods such as chemical treatment as represented by the Chemigroundwood work, increasing the proportion of coarse fibers with subsequent refining and fractional screening show evidence of gains in strength to the degree required. Further work with stone grit types and specifications and burring techniques will no doubt be carried out, but from the emphasis this has received in the past and judging the results obtained to date, future results do not appear promising.

In the absence of G. G. Cole, Diamond Match Co., his paper, "Fields for Groundwood in the Manufacture of Napkins, Tissue, and Toweling," was given by W. H. Monsson of the Hooker Electro-Chemical Co.

Fields for Groundwood in the Manufacture of Napkins, Tissue, and Toweling

Grant G. Cole

This paper will of necessity be brief for there is little to relate about the use of groundwood in household papers that is not already quite obvious. Groundwood, once frowned upon as an intruder in the manufacture of fine papers, has now been fully accepted as a necessary and integral part of many sheets. History relates that the first commercial groundwood operation began in Europe in 1846; however, it was 20 years later before such production was started in the Western Hemisphere.

This slow acceptance of such stock was due to several reasons: first, groundwood in itself had—and still has—rather low strength properties, second, for many years no satisfactory method of bleaching was available; also, its feel or softness did not rate high compared to chemical pulps. These reasons, plus the fact that sheets containing groundwood tend to deteriorate more rapidly upon aging, gave justification for the retarded growth of this valuable fiber.

Grant G. Cole, Diamond Match Co., Plattsburg, N. Y.

Audience at Mechanical Pulping Panel Meeting

With the rapid development of better techniques in production the inherent undesirable characteristics have been overcome to the extent that groundwood is now a valuable asset in many paper mills. Its use is becoming less restricted as time passes; we find it appearing in more grades and in greater quantities than ever before.

Commercially there are sound and obvious reasons why this should be true. Probably the first is that the ever present dollar sign has to be considered. As we all know, the cost of production of a ton of groundwood pulp is considerably below that for the production of a ton of any type of chemical pulp. The yield per cord of raw material is approximately 2 tons of groundwood as compared with about 1900 to 2000 lb. of other chemically produced fiber. Further, in these days of rapidly depleting woodland areas, we must look to the optimum utilization of the pulpwood stands that are left. It is obvious that such conservation must be practiced rigorously, therefore, groundwood, with its high yield, plays an important role in this respect. Coupled with these commercial values is the fact that groundwood makes a highly satisfactory filler for chemical pulp; sheets containing these shorter fibers are of more uniform and denser formation.

The undesirable characteristics mentioned above have been overcome or at least minimized through ever advancing scientific techniques. The low strength properties have been largely averted through more closely controlled grinding and refining operations until today it is possible to produce fibers that average considerably stronger than those made in the first commercial pulp mills. This in turn has given control to the softness of sheets containing percentages of groundwood and has made possible its use in many fine grades of paper.

Bleaching methods are now available that will give a brightness comparable to that obtained by chemical pulps. True, groundwood fibers will revert in color over long periods of time, especially if exposed to large amounts of sunlight. However, this is not a serious problem where product turnover is kept at a steady rate. This means that groundwood fiber can be used immediately, where in the past brightness has been the principal restriction. It also appears that alkali bleaching operations reduce the harshness that has been noted to develop in the aging process. This is, of course, a very definite advantage in certain grades of tissue sheets.

In the tissue and napkin grades, fiber counts of reputable brands show that a considerable amount of the furnish is comprised of groundwood fiber. This is accomplished with with little or no loss of softness; strength is lowered to some degree from that of an all sulphite sheet. Groundwood definitely aids in sheet formation, runs well on the paper machine and causes no trouble in the converting operation. It appears that the main restriction to use in large percentages lies in the competitive high brightness standards prevalent in the industry.

Much of the paper toweling on the market today is of the wet-strength variety. Groundwood is of no detriment in this application—it being true that this fiber is more substantive to wet-strength additives on aging than is sulphite itself. With the proper choice of groundwood fiber and rewetting and wet-strength agents, a towel of outstanding quality can be produced. Groundwood percentages here are limited only by brightness and strength requirements since it is possible to go to the point where even wet-strength addition can no longer be of benefit.

In conclusion, it may be said that this fiber, held in such low esteem by papermakers of the past, has finally taken its proper place in the manufacture of many grades of fine papers; undoubtedly some of the objections that still exist to its more widespread use will be overcome through better control of its manufacture and application.

In the last paper of this panel, John McGovern, Forest Product Laboratory, spoke on the "Status and Outlook on the Production and Utilization of Semichemical Pulps and Other High Yield Pulps." Advantages of the neutral semichemical process, as well recognized, include higher yields than are possible with full chemical processes, particular suitability for pulping hardwoods, and products of special value for glassine, book and bond papers, and corrugating board.

Recent Trends in Pulp Bleaching Processes

The third panel discussion, "Recent Trends in Pulp Bleaching Processes" was presented Friday morning, June 20, with Ferdinand Kraft, Marathon Paper Mills of Canada, serving as moderator to introduce the opening paper. This paper was prepared by E. J. Thom, Howard Smith Paper Mills, Ltd., and was read by D. D. Cameron of the Alliance Paper Mills. The continuing steady expansion of bleached sulphite in the United States from 751,000 tons in 1930 to 1,612,000 tons in 1940 and to 2,106,000 tons in 1950 was illustrated. The rapid growth in the United States of bleached and semibleached kraft from 66,000 tons in 1930 to 424,000 tons in 1939, and 1,790,000 tons in 1950 was discussed and its corresponding development to 546,000 tons in Canada for the year of 1951 was noteworthy. Statistics were also presented for bleached soda pulp production in the United States and for bleached sulphite in Canada.

A special feature of this panel was the floor discussion on three of the subjects, Chlorine Dioxide for Bleaching Chemical Pulps; Peroxides for Bleaching Chemical Pulps; and Hydrosulphites and Sulphur Dioxide for Pulp Bleaching. Ably led by Mr. Kraft who furnished an introductory background, the latest developments in these fields were covered by mill men and suppliers.

Peroxide Bleaching of Groundwood

Richard A. Premo

THE use of peroxide in pulp bleaching processes has been the subject of recurring researches since early in the 20th century.

Bleaching of mechanical pulp became of special interest in the United States along about 1940 when many of the newsprint mills were facing the necessity of converting their mills to the manufacture of higher grade papers. Mechanical pulp was known to impart desirable characteristics to paper, such as high capacity, good formation, and excellent printing properties. In a thorough study of the peroxide process for bleaching mechanical pulp made in the Du Pont laboratory the best conditions for operating the process were defined. This resulted in the first extensive mill trial on the production of printing paper with bleached mechanical pulp in the furnish at the Norfolk mill of the St. Regis Paper Co. in 1941.

RICHARD A. PREMO, Technical Director, Gould Paper Co., Lyons Falls, N. Y.

Pulp Bleaching Panel: John Simmonds, Forest Products Laboratories; Richard Premo, Gould Paper Corp.; Ferdinand Kraft, Marathon Corp.; Carl Fries, Rhineland Paper Corp.; D. A. Cameron, Alliance Paper Mills, Ltd.

The success of this run may be substantiated by the fact that today peroxide bleaching processes are in commercial operation in a total of 36 pulp and paper mills, and a number of installations are in different stages of completion. These peroxide bleaching processes include bleaching of groundwood, bleaching of chemical pulp, and recovery of waste paper.

PEROXIDE BLEACHING OF GROUNDWOOD

Peroxide bleaching of groundwood is a simple process which includes the following four basic operations: (1) preparing the peroxide solution, (2) mixing the peroxide solution with the pulp in controlled proportions, (3) retaining the peroxide-treated pulp long enough to permit bleaching to go to completion, and (4) reducing the residual peroxide and neutralizing the bleached pulp to the pH desired for the paper furnish.

The chemicals used in the process include hydrogen peroxide or sodium peroxide or both, sodium silicate, sulphuric acid or caustic soda, magnesium sulphate, and a reducing and neutralizing agent such as sulphur dioxide, sulphite cooking acid, sodium metabisulphite, or sodium bisulphite.

As a source of active oxygen, hydrogen peroxide and sodium peroxide are interchangeable. For groundwood bleaching operations in general, the alkali content of sodium peroxide exceeds the amount required for best results. When the bleaching solution is prepared with sodium peroxide as the sole source of active oxygen, the alkali supplied by sodium peroxide must be partly neutralized. This is done most economically with sulphuric acid. Hydrogen peroxide, on the contrary, is slightly acid in character. Consequently, when the bleaching solution is prepared with hydrogen peroxide as the sole source of active oxygen, some caustic soda or other alkali must be used to provide the required alkalinity. By using hydrogen peroxide and sodium peroxide in the proper proportions, the use of both sulphuric acid and caustic soda can be eliminated.

Sodium silicate has the properties of a detergent and a penetrant. It buffers the bleaching solution and aids in maintaining the pH in the desired ranges. It forms a protective coating on the surface of metals and inhibits corrosion of metal equipment. It also has a stabilizing action on peroxide solutions under the conditions which prevail in the pulp bleaching process.

Magnesium sulphate in small amounts has a remarkable stabilizing effect on alkaline peroxide solutions under the conditions which prevail in pulp bleaching processes. It performs this function by inhibiting the catalytic effects of the traces of metals, particularly iron, copper, and manganese which are commonly present in pulpwood and mill waters.

BLEACH LIQUOR PREPARATION SYSTEM

The peroxide bleaching solution is prepared either batchwise or in a continuous, automatic system in which the water and the chemicals are metered proportionally. While the manual batch operation was widely used in earlier installa-

The breakfast meeting of the Pulp and Paper Alumni of the State College of Forestry at Syracuse University which was held on Friday, June 20, during the Joint Convention of the Niagara Branch of the Technical Section of the CPPA and the Empire State Section of TAPPI at the General Brock Hotel in Niagara Falls, Ontario

tions, improvements made in chemical handling by equipment manufacturers have led to the recent development of the continuous automatic system..

I have found that the continuous automatic method for preparing the peroxide bleaching solution offers advantages over the batch method in that it: (1) has simplified the chemical handling necessary in operating the bleachery, (2) minimizes the active oxygen losses by being able to operate with a small amount of bleach liquor in storage, and (3) the cost of the equipment is lower than necessary to operate the batch system.

We at Gould Paper Co. have a great deal of respect for the continuous method and I would like to present a few slides to illustrate its operation.

The first showed the continuous method of preparing the sodium peroxide bleaching solution which involves the flow of water at a metered rate through a four-compartment stainless steel tank (10 by 3 by 3 ft.). Each compartment is equipped with a stainless steel agitator. Epsom salt, added from a dry feeder, is dissolved in water bypassed from the meter and returned to the first compartment. Sodium silicate is also added to the first compartment. The sodium peroxide is added to the second compartment by a loss-in-weight dry feeder. Sulphuric acid is added to the third compartment. The bleaching solution overflows the fourth compartment which serves as a sampling reservoir and flows to a tile storage chest.

Slide no. 2 showed the continuous method of preparing a peroxide bleaching solution from hydrogen peroxide which involves the flow of water at a metered rate through the same size compartments as slide 1. Epsom salt and sodium silicate are added to the first compartment, caustic soda is added to the second compartment, and hydrogen peroxide is introduced in the third compartment. The bleaching solution overflows the fourth compartment which serves as a sampling reservoir and flows to a tile storage chest.

The last slide showed the continuous method of preparing a sodium peroxide–hydrogen peroxide combination bleaching solution. The flow of water is at a metered rate through the same size compartments as shown in the previous slides. Epsom salt and sodium silicate are added to the first compartment. The sodium peroxide is added to the second compartment by a loss-in-weight dry feeder. Hydrogen peroxide is added to the third compartment. The bleaching solution overflows the fourth compartment and flows to a tile storage chest.

TYPES OF BLEACHING

Pulp bleaching may be divided into three classes:

1. *Low Consistency Bleaching* where the consistency of the stock at the time the bleach liquor is added is (4 to 6%).
2. *Medium Consistency Bleaching* where the bleaching takes place at a pulp consistency of (9 to 15%).
3. *High Consistency Bleaching* where the consistency of the pulp at the time the bleach liquor is added ranges from (20 to 50%).

TYPICAL OPERATION

In a typical operation of a medium consistency the groundwood slurry is metered to the system at a controlled consistency and pumped to the thickener. The sheet of thickened pulp is shredded and drops into the conveyor which collects the pulp from across the discharge face of the roll and drops it into the single-shaft mixer where the pulp is mixed with steam to obtain a pulp temperature of approximately 110°F. From the single-shaft mixer the heated pulp passes into the double-shaft mixer where the peroxide bleaching solution enters the process at this point and is well mixed with the pulp in passing through the double-shaft mixer. From here the pulp drops by gravity into a retention tower where it remains from $1^1/_2$ to 3 hr. At this point the pulp pH is 9.0 to 9.5 with a residual peroxide of about 10%.

The pulp is then taken from the tower by a scraper and metering type screws and neutralized with sulphur dioxide in the neutralization chest. In this step sufficient sulphur dioxide is used to reduce the pH to 6.5 to 7 which is ample to eliminate any residual peroxide. From the neutralization chest the pulp is pumped at a controlled consistency to storage.

CONCLUSION

It has upgraded our paper enabling us to make sheets having a G.E. brightness of 68 and better using our own pulp which previous to peroxide bleaching was out of our range of distribution potential.

Peroxide bleached groundwood has increased our mill potential by enabling us to make a wider range of specialty and printing papers.

In view of these facts we at Gould Paper Co. believe that the introduction of peroxide bleached groundwood to the paper industry has opened an entirely new field for groundwood printing papers and specialty.

F. A. Simmonds, Forest Products Laboratory, Madison, Wis., spoke on "Bleaching of Semichemical Pulps." This process in recent years has become the fastest growing pulping process and successful bleaching has opened new possibilities. Typical single and three-stage bleaching processes were described. Brightnesses of 82 to 84 were obtained on many hardwood pulps by three-stage bleaching.

Karl Fries, Rhinelander Paper Co., Rhinelander, Wis., gave his experience in "Mill Bleaching of Semichemical Pulps." His talk illustrated how the information and research of the Forest Products Laboratory had been carried on and developed to a commercial possibility by Rhinelander. The semichemical aspen-bleached pulp thus produced could be used in

Ladies' Bridge and Canasta Party, St. Catharines Country Club

glassine paper. Unexpected difficulties such as poor washing properties were described and remedies discussed.

In the final paper, "Purification of High Alpha Pulps from Hardwoods," Mr. Simmonds illustrated by means of a large chart the types of high alpha pulps which could be prepared from various hardwoods studied at the Forest Products Laboratory.

Golf and Bridge Parties

After the first three panels presented on Thursday morning and afternoon and on Friday morning, the men relaxed on Friday afternoon to enjoy an afternoon of golf. Under the warm June sky at Lookout Point Country Club, some 50 golfers competed for prizes. Top prize, low gross for 18 holes, was won by Empire State TAPPI Chairman, Bob Drummond, International Paper Co. Charles Baker, Newton Falls Paper Co., won the low net for 18 holes.

At the same time, 50 ladies enjoyed the hospitality of the St. Catherines Country Club. A committee of Mrs. Russell C. Shearer, Mrs. Murrell Eldridge, Mrs. J. J. Forsythe, and Mrs. A. B. Gorham arranged for luncheon, bridge, canasta, and golf for the afternoon.

In addition, the ladies enjoyed a scenic tour of Niagara Falls and visits to the Royal Horticultural College, Community Silver Plate Co., the Ontario Hydroelectric Co., Welland Canal, and other points of interest during the convention.

Quality Requirements by Paper Consumers

On Saturday, June 21, Russell Shearer, Alliance Paper Mills, Program Chairman for the meeting, introduced R. J. O'Brien, Moore Business Forms, who presided as moderator at this panel meeting.

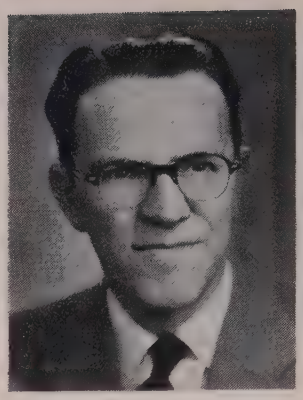
Magazine Paper

John Brown

INSTEAD of talking about many grades of paper, I should like to confine this paper to one of our operations, which is—the printing of approximately 300,000,000 eight-page inserts per year for *Life* magazine, using one-half million pounds of machine-coated paper per week. This work is produced on two double, five-color heat set presses, operating in the neighborhood of 1000 f.p.m. From reel to folder, the web lead is approximately 300 ft. which flows through the printing and drying units. After printing, the web is subjected to 600°F. and the moisture content of the sheet is dropped to about 1% which makes the stock weak and brittle. The stock must be nearly perfect to operate satisfactorily.

JOHN BROWN, J. W. Clement Co.

Quality Requirements by Paper Consumers' Panel (Left to Right): John Brown, J. W. Clement Co.; R. J. O'Brien, Moore Business Forms; Russell Shearer, Alliance Paper Mills, Ltd.; Charles Cornell, Packing Assn. of Canada; G. D. Geffken, Seal-Rite Corp.



R. J. O'Brien, Moore Business Forms

Lyman Beeman, Finch, Pruyn & Co., Inc.

The waste figure of this operation is quite staggering. Of each ten cars of paper which are brought into our plant for this operation, one goes out in the form of wastepaper. The high percentage of waste is due to many causes—namely, plates, ink, malfunction of the press, design of the press, nature of the subjects being reproduced, and faulty paper from a mechanical and printability standpoint. In addition to wastepaper from these causes, which is very expensive, is press down time resulting from web breaks and forced press stops due to printability variations. How many of you have received this type of report regarding the performance of your paper, such as, "Your paper is no damn good." You then ask, "What is wrong with it?" The answer very likely will be, "It won't run," or "It won't print." We of the J. W. Clement Co. feel that it is our responsibility to pass on to the paper manufacturer complete information as to the performance of his product. This picture must be a true one. Paper must not be blamed for press, plate, and ink ills—because we would only be kidding ourselves. This information is possible by keeping a complete record of each roll of paper which we receive regarding its performance. A weekly report is sent to the paper manufacturer, regarding performance of the previous week, accompanied by printer's report cards, evidence showing defects and signatures representing the printing quality of his stock. On an average of every two months a meeting consisting of representatives of the publisher, printer, and paper manufacturer, is held to go over the current performance of the stock. This meeting is called at the first sign of trouble so as to get to the bottom of this trouble before too much paper has been manufactured and stored.

To enable us to keep abreast of trends, we have set up a system whereby a representative portion of each car of stock is run on the press within a day or two after its receipt. What has been gained by the cooperative efforts between the printer and paper manufacturer?

(1) In the past three years on all regular runs, the percentage of waste has been dropped by approximately 2%. (2) The uniformity of printing quality, as well as over-all quality has improved. (3) Web break delays have been reduced from 10 to 2 hr. per 100 rolls. (4) Over-all press operating efficiency has improved by approximately 20%.

What did the paper manufacturer do to improve our operating efficiency and just how did it help our operations? First, we must take for granted that he had eliminated the everyday cause of web breaks such as calender cuts, hair cuts, slitter nicks, bad splices, etc. This improved our efficiency because time consumed in repairing web breaks amounts to approximately 20 min. or a production loss of 15,000 inserts with a paper waste resulting from web breaks and printed waste of approximately 100 lb. He gave us paper of uniform moisture content from roll to roll, throughout the roll and across the roll, of less than $\frac{1}{2}$ to 1% spread. By doing so, he

Left to Right: K. P. Geohegan, Howard Paper Mills; J. M. Stephenson, Pulp & Paper Magazine of Canada; *R. M. Drummond, International Paper Co.; John Clouse, Oxford Miami Paper Co.; Gordon K. Storin, Niagara Alkali Co.; Herbert Karberg, Alliance Paper Mills, Ltd.*

eliminated a very large percentage of finish variation. His smoothness improved, his caliper spread dropped to plus or minus one 10 thousandth of an inch and dimensional stability became very good. With these improvements, press make-ready time dropped and uniform ink receptivity was achieved. It was possible to increase our press speed due to the absence of wet streaks which affect our drying. Wet streaks make it necessary to decrease press speeds by 15 to 20% due to the fact that we must dry our first side printing to the point that the stock is nearly moisture-free before the solvents are flashed from the ink. Paper was shipped and stored on end to eliminate much concealed and handling damage. It also eliminated elliptical or bumpy rolls. Roll stock which is handled and stored on end remains very round. Rolls which are bumpy result in many missed flying pasters, as well as create excessive web breaks and distorted tensions. A printer's report card accompanies each roll. As this roll is run on the press, a complete history of its performance is indicated on this card. This from both a mechanical, as well as printability standpoint, is recorded. If the roll is "ok" it is indicated as such. These report cards are then returned to the mill, reflecting performance with evidence of defective material.

Rolls are given a code letter before the roll number, indicating month of manufacture. This makes it very easy for the pressroom to isolate lots of stock which are not quite up to par. This stock is then used on a press run which may not be so difficult or on a run which is not running to a very tight schedule, thus eliminating much down time from breaks, as well as press stops for make-ready and attempts to overcome variation in printability. Rolls have been clearly identified to their position in the log, that is, front, center, and back. By trial and error, we know what type of form should run on a front or center roll for the best mechanical performance. These rolls are run in very nearly the same sequence in which they are manufactured. By doing so, all types of variation have been cut to a minimum. The change in uniformity is very slight and these changes come gradually so as to enable the press crews to make necessary adjustments infrequently and not in each roll change, resulting in the production of a product of much more uniformity with a higher degree of efficiency.

I should like to leave this thought in your minds—that in addition to mechanical performance, uniformity from roll to roll and throughout rolls and from lot to lot of stock is one of the most desirable qualities. In other words, if a high standard of quality cannot be maintained, it would be more desirable to lower the standard and yet maintain uniformity, because adjustments for variations from roll to roll and throughout rolls, create more lost press time and waste material than any other cause.

Consumer's Quality Requirements for Board and Container Papers

H. M. Gray

Board and container papers are used to package and display a wide variety of materials ranging from facial tissue and paper food containers to television picture tubes and glass stemware.

For the most part container papers are the source of little or no trouble to the consumer as shipping containers. In this discussion the term "container paper" applies to corrugated shipping containers.

In 1951 the Sealright Co. consumed 76.8 million sq. ft. of container board. The average carton is quite large and contains 22 sq. ft. of board. The number of cartons consumed totaled almost 3,520,000.

The principal faults experienced with corrugated containers are:

1. Boxes incorrectly printed.
2. Tape loosens and/or breaks at the manufacture seam causing particles of asphalt to enter the carton and damage high-grade merchandise. The suppliers of Sealright cartons no longer use asphalt laminated tapes.
3. Poor gluing—rough finish, surface too absorptive. Poor taping of filled carton. Usually this problem is not the fault of the carton manufacturer.
4. Outer flaps do not meet.
5. Separation of corrugated medium from liner.

Several other factors which have to be observed with great diligence are the complete absence of odors—kerosene, pine oil, and phenolics—particularly in those containers used to package foodstuffs.

One new problem to which considerable attention may be focused has been brought about by this new atomic age—the problem of radioactivity in the paper used to fabricate the shipping container. Certain consumers have made technical inquiries as to the possibility of using only deep well water instead of surface water which may suddenly receive radioactive elements recently released in a planned blast at Los Alamos or from an unscheduled atomic explosion. Photographic and other sensitized papers would be greatly affected by radioactivity.

But by and large there are relatively few complaints in the container business because detailed information about the product to be packaged is submitted to the manufacturer of the carton.

The qualities of paperboard pertinent to the consumer who is concerned with the functional and decorative aspects of packaging are in order of importance:

1. Cleanliness—the board must be free of slime spots, dirt, asphalt, objectionable odors and chemicals such as sulphur.
2. Strength—low strength as well as excessive strength are sometimes encountered.

H. M. Gray, Sealright Corp., Oswego, N. Y.

Ferdinand Kraft, Marathon Corp. of Canada; Fred C. Goodwill, St. Regis Paper Co.; Lyman Beeman, Finch, Pruyn & Co.; W. H. Monsson, Hooker Electrochemical Co.; J. S. Reichert, Du Pont Co.

3. Uniformity of caliper—high-speed packaging machines and printing presses will not function properly on board of varying caliper within the sheet.

4. Wet paper—shrinkage of blanks which are formed while wet.

5. Curl—sidecurl and roll set disrupt efficient feeding on converting equipment. This problem can occur during shipment to the ultimate consumer and can occur while in storage under adverse conditions.

6. Ply adhesion—the new high-speed presses such as the Champlain and the Manhasset have accented or aggravated or created problems that did not exist or were not objectionable prior to the installation of these new high-speed presses which are equipped with small diameter rolls. Bonding the sheet properly has become very important. Cylinder blows also occur too frequently and when they do are usually detected immediately after printing on the above-mentioned presses. In our line of products ply adhesion is critical at the glue line of the conical milk bottle, at the point where the saw cuts the cylindrical can and in the crimping action on the Nestyle container.

7. Bender—scoring problems are familiar to everyone in the business. Sealright encounters occasional trouble on the bottoms of cylindrical cans where the bottom disk is crimped.

8. Checking—board with small checks is very frequently used without complaint. However, when a checked board is coated or laminated or printed and sometimes a combination of all three operations are requested then a checked board is valueless. Frequently a creep condition is created when the board is converted on equipment with small rolls.

9. Printability—some of the obstacles to good printing are:

Scabs: too frequently scabs pass inspection and damage plates.

Splices: poor splices due to inadequate wetting of the gummed tape. The use of masking tape for splicing has caused considerable trouble because the masking tape has transferred to rubber rolls or rubber blankets. The result is either a plugged press or sometimes a damaged blanket.

Smoothness and fuzz: rough edges, dry water box, felt marks and fuzz or stubble on the surface of the sheet raise havoc with coating and printing operations. Considerable trouble results from rough edges and fuzz on the sides of roll stock, the fuzz builds up in the fountain and in the plates causing frequent shutdowns for wash-ups.

Hard spots and wet spots.

Calender treatment: difference in application across the sheet.

Color: variations in shade during a run and on different runs.

10. Formation—wild liner, insufficient liner.

11. Waterproofness—not all complaints of poor sizing are due to size. The presence of wax spots (low melting point) in board used for hot drinks usually results in leakers. Nonuniformity of sizing occurs too frequently within the same shipment.

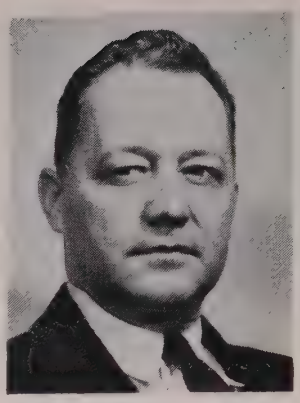
Most of the problems cited are not new. In our company the biggest complaints are split board, poor printing surface or poor coating surface, checking, and occasionally strength (high tear and low stiffness).

At the 1950 meeting of the American Pulp and Paper Mill Superintendents' Assn. a paper entitled "Common Faults of Paperboard and Their Correction" was presented by F. H. Stowitts. At this meeting Messrs. Stowitts, Hadley, Whims, and Beason discussed at great length most of the problems listed in this paper.

Greater diligence and vigilance are absolutely necessary in order to survive and prosper in these changing times. There is still too much of a feeling that anything coming off the paper machine can be used by the converting plant, if, the paper mill allows the paper to stand in storage for several months and then feeds the defective material to the converter a few rolls at a time.

Of course the paper mill solves their problem of what to do with the off-quality board, but they have really disrupted the oiled machinery of the converting plant. Introducing an occasional defective roll makes it difficult to detect substandard merchandise. After the converter has worked his way out of trouble and he allows himself to relax knowing that he is out of trouble another defective roll is put on and the cycle is renewed.

More diligence, more examination, and more exercise of good judgment are necessary in the converting plant. There is no reason in the world why paper that is obviously wet, bonded poorly, rough, or badly checked should be labored with and unacceptable merchandise turned out.



Russell Shearer, Alliance Paper Mills, Ltd.

G. A. Day, Brown Co.

Since we believe it is true that the most valuable asset of any business is its customers we in the converting field are prepared to do our best to meet any standard which the customer finds necessary to establish to meet the end-use requirements of his consumers and to aid in constantly enlarging his volume of use. We believe that what is good for his business is good for the converting business and as manufacturers of paperboard as well as converters, we know that what is good for the consumer is good also for the manufacturer of the paper or the board.

Recently we have entered a period of increasing severity of competition necessitating substantial tightening of paper and paperboard requirements to meet end-use demands. This change came as an abrupt shock to the converters and to the pulp and paper industry after a period of almost ten years of uninterrupted shortages during which a sellers' market prevailed. We are now in a buyers' market and those that would succeed, prosper, or indeed survive the present era will be those who make the necessary mental adjustments in their own organization and mechanical adjustment of their equipment to meet the most exacting demands of the purchaser.

"Consumer's Quality Requirements for Bond and Writing Papers" were discussed by B. L. Corbett of the R. L. Crane Co. This paper, read by Russell Shearer, Alliance Paper Mills, stressed the importance of moisture in such operations as the production of continuous business forms in which punching, collating, and feeding of the forms must be maintained to very close tolerances.

In the final paper of the session, Charles Cornell, Packaging Association of Canada, spoke on the topic, "Quality Requirements for Food Packaging Papers." The importance of having a complete story on the material to be packaged was stressed. Mr. Cornell also discussed briefly the activities of the recently formed Packaging Association of Canada.

Maine-New Hampshire

The annual meeting of the Maine-New Hampshire Section was held June 20–21, 1952, at the Belgrade Hotel, Belgrade Lakes, Me. Over 200 people were in attendance at the various sessions, which comprised a technical program on Friday afternoon, June 20, and Saturday morning, June 21. A very successful clambake was featured on the shore of the lake on Saturday noon with lobsters, clams, and all that goes with such an affair. A golf tournament and fishing derby were scheduled for the sports program during the afternoon.

At the annual business meeting, under the leadership of retiring chairman, George A. Day, the following section officers were elected for the ensuing year: Joseph J. Thomas, S. D. Warren Co., Chairman; Arthur E. Jones, Oxford Paper Co., Vice-Chairman; H. E. Pratt (re-elected), Pejepscot

A. Jenkins, Bird Machine Co.

H. A. Morrison, Oliver United Filters, Inc.

Paper Co., Secretary-treasurer; and J. F. Wright (re-elected), Allied Chemical and Dye Corp.; A. E. Bachmann, Missisquoi Corp., and F. N. Sprague, St. Regis Paper Co., as members of the executive committee (three-year terms).

The main theme of the first technical session was "clean stock," which was opened by a paper entitled "Problems of Clean Stock," by A. Jenkins, Bird Machine Co. The author discussed in general the business of cleaning paper stock, giving emphasis to such questions as (1) what is dirt, (2) where does it come from, and (3) how can it be kept out or removed from stock. The papermaker's problem is to keep dirt out of the system or to remove it if it is present.

The cleaning of paper stock may be accomplished by separation by size or through difference in density between the dirt and the fiber. The three accepted types of dirt-removal equipment are rifflers and sand traps, centrifugals and drop-in pressure units, and screens.

The two latter types of equipment were described in greater detail by the speaker. The Bird Centrifiner is an example of the revolving basket-type centrifuge, while the Dirtec is a vortex-type separator. Examples of screens in general use are the Bird rotary screen, embodying the principle of inward flow, the Bird-Jonsson screen of the oscillating or vibating type, and the Bird-Vibrotor screen which combines the principles of rotation and vibration.

In conclusion, Mr. Jenkins stressed that clean paper stock can be obtained only if operators remain alert and continually guard against all forms of dirt contamination during storage, preparation, and handling of raw materials. Internally created dirt arising from chests and piping must be held to a minimum. The various types of dirt-elimination equipment must be of adequate capacity, must be operated efficiently, and must be kept clean.

H. A. Morrison, Oliver-United Filters, Inc., read a paper on the "Up-Flow Screening of Chemical Pulp," prepared by W. H. Pitkin who was unable to be present. This was a description of the Oliver-Ahlfors screen which utilizes a new screening principle—the upward flow of pulp through the screen plates, rather than downward as on conventional flat screens. The operation of the equipment is as follows: pulp is fed to the screen vat from a headbox at controlled capacity and under a positive hydraulic head. Stock is screened upward through the screen plates under gentle agitation from the vibrating diaphragm.

Accepted stock overflows at the right end of the screen and out the stock outlet. Dirt, shives, scale, and oversize particles remain in suspension in the screen vat and pass out through the reject outlet. The volume and consistency of the reject flow are controlled by the adjustable sleeve on this reject outlet.

An automatic traveling shower moves back and forth across the top face of the screen and prevents plugging of the slots, thus keeping the plates clean at all times, and permitting high capacity.

Over 100 installations have been made on various types of bleached and unbleached pulps in Europe using the original design as developed there. The screen as now offered in this country has been modified in minor respects to conform to American standards of manufacture, and for local pulps.

The present screen uses four screen plates per unit, whereas the original had a single larger plate. The amplitude of vibration has been reduced and the speed of vibration of the diaphragm has been increased from 900 to 1300 r.p.m., resulting in some improvement in capacity and performance.

The screen frame or vat, is composed of two stainless steel end castings and connecting side rails. The pulp inlet is cored in one of the end castings and the outlet in the other. Seven extra heavy stainless cross bars tie the side rails together and serve as supports to which the screen plates are bolted. This frame is then bolted to the vibration dampener at the machined base of the end castings.

Because all of the screen plates operate under the same positive, uniform, hydraulic head in upflow screening, substantial increase in capacity is possible in terms of tons of pulp per square foot of screen area. Further contributing to improved capacity is the use of more slots per inch of plate surface.

With upflow screening principle, there are no dry plates, thus eliminating the pounding of rejects through the screen plates as can happen with dry plates on conventionl flat screens. For the same reason there is no addition of dilution water required to prevent dry plates.

Because of high capacity per screen, there is a substantial saving in floor space required, this saving amounting to as much as 50% in many instances. This means a saving in initial investment in screens themselves, plus savings in building costs in new mills, and making valuable space available in existing overcrowded mills. The screen operates with higher consistency pulps, which reduces the area required for subsequent deckers, and again reduces the floor area nominally required for these deckers.

The screening area is totally enclosed in a hood. In this way, the pulp being screened is protected against contamination from dust and dirt in the screen room. It also prevents splash and permits a dry and neat station.

Other design features include variable speed vibrator drive mechanism; low power requirements; low maintenance; and many others.

Frank C. Duval, Shartle Bros. Machine Co., read a paper, prepared by W. A. White, on centrifugal cleaning equipment. He pointed out that the use of centrifugal cleaning equipment has advanced rapidly during the past ten years. One reason for this advancement is found in the fact that mills are making paper and board from a greater percentage of wastepaper than ever before. The second reason is that mills using wastepaper have continually increased production and find that existing equipment will not yield a sheet meeting customer specifications. Equipment manufacturers are faced with two problems:

Harold Ingalls, Nichols Engineering & Research Corp.

W. A. White, Jr., Shartle Bros.

They must make machinery which produces stock requiring the minimum amount of treatment and at the same time yielding a clean stock with the least amount of wasted fibers in the rejects. Removal of all foreign material cannot be accomplished by one machine. A wastepaper cleaning system comprises a Hydrapulper equipped with a ragger and junk remover, Hydrafuge separator for the removal of grit, followed by Classifiners. Paper stock not defibered is then removed with the floating rejects which flow by gravity to a disintegrator which quickly reduces and defibers the large particles of paper stock and fine fiber bundles. The discharge of this unit goes to a Selectrap which acts as a tailing screen for reclaiming the rejected fiber. The accepted stock from the Selectrap flows back to the Hydrapulper and is returned to the system as reclaimed fiber.

Three centrifugal stock cleaners were described by the speaker and the advantages of each one listed. These three cleaners are the Miami Centrap, Elutriator, and the Hydrafuge separator. The Miami Centrap is a high capacity multiple basket capable of handling from 500 to 2000 air-dry pounds of high-grade stock per hour. Each of the three baskets discharges separately into a common gutter where the clean stock flows by gravity either to the paper machine screen or to the machine headbox.

The Centrap is not self-cleaning and requires a wash-down normally once a day.

The Elutriator makes use of centrifugal force at low intensities to produce the required separation. Its advantages are low horsepower consumption, minimum space requirements, lack of close clearances, and the unit is self-contained.

The Hydrafuge separator employs a straight-through flow pattern from the inlet to the outlet of the unit. No reverse flow is set up during the centrifuging operation causing undesired turbulence and entrainment of rejects. It possesses no close clearances to clog. The rejects are discharged from the unit approximately 60% dry into a trash cart or box, and it is shipped completely assembled and ready to run.

In concluding his paper Mr. Duval reiterated that through the cooperative efforts between mills and machinery manufacturers objectionable grit can be removed from fiber stock by first determining a standard which will give an acceptable sheet of paper and then the correct application of cleaning equipment so that the mill will economically produce and ultimately satisfy their customer's requirements.

Harold E. Ingalls, Nichols Engineering and Research Corp., discussed centrifugal stock cleaning by means of the Vortrap. Until recently the 4-in. Vortrap has constituted practically all sales. It was recognized that it was unexcelled for high quality furnish, but limited in its capacity to remove large quantities of coarse dirt and foreign matter.

Other Vortraps, namely the 1.5, 3, 4, 6, 8, and 10-in., now available, were developed to be adapted to the effective

Edwin V. Kemp, Bauer Bros. Co.

James P. Nolan, Oxford Paper Co.

View of one half of meeting room on afternoon technical session

cleaning of any or all of the different kinds of paper furnishes. The smaller the Vortrap, the more efficient is the cleaning job, and the more power is required per gallon per minute up to its top rated capacity. Thus it can be seen that the 4-in. Vortrap remains the most practical unit for the highest degree of cleaning on stocks containing normal amounts of foreign matter.

Primary-secondary Vortrap systems were introduced as larger installations became necessary. This system uses an active bleed of rejects followed by dilution in order to obtain a continuous discharge of rejects without excessive fiber losses. This system has proved itself to be more efficient in the removal of bark and shives, and eliminates the necessity for manual dumping of the waste receivers, except at times of machine wash-ups.

Tertiary systems were developed to further reduce the loss of acceptable materials such as fibers and fillers. Many such systems have shown losses as low as 0.5 to 1 lb. of acceptable fiber per ton of finished paper with a similar proportionate decrease of filler losses.

In pulp mills where the volume of stock to be handled is particularly large, the 10-in. Vortrap may be substituted for the primary, followed by the usual 4-in. secondary system. This assembly is efficient since the 10-in. primary has the advantage of handling a much larger volume of stock with reduced power requirements. Following the same principles of dilution and control in secondary Vortraps, this system has the advantage of removing the lighter dirt in the efficient smaller Vortrap.

It is necessary, however, to understand that the customer sets the standards for the type of cleaning job he wants. Effective stock cleaning can only be done after careful consideration of the job to be done and "Cutting the cloth to fit the job."

Edwin V. Kemp, The Bauer Bros. Co., read a paper on the Centri. Cleaner which was prepared by G. H. Tomlinson and N. G. M. Tuck, Howard Smith Paper Mills, Ltd. This presentation described the experience the Howard Smith mills have had with Centri. Cleaners in their kraft mill at Cornwall. This equipment is also being installed at the sulphite mill. These Centri. Cleaners have 4-in. inlets and 4-in. outlets with a 10° cone, possessing a capacity of 850 g.p.m. per machine with a consistency of 1.23% for unbleached pulp and 0.85% for bleached pulp. Three primary Centri. Cleaners and one secondary are being used on the unbleached stock, while four primaries and one secondary are employed for the bleached stock. Unless the wood contains much dirt, it is not necessary to use Centri. Cleaners on the bleached stock. Maximum production of this equipment is 195 tons per day.

About 0.2% of the stock is rejected to the sewer, although

the Centri. Cleaners can be arranged so as not to reject any fiber. Also cleanliness was improved remarkably after the installation. Centri. Cleaners installed on the paper machines to clean fly ash from the stock were 99% efficient.

The lower the consistency, the better the results. To completely remove shives more than one pass may be necessary. It was found that the machines give better performance with heavy dirt. The tangential inlet and the large area of the Centri. Cleaner are basic differences from the Vortrap and the Dirtec.

At the Saturday morning session, which was attended by the ladies as well as the men, a scenic color-sound motion picture entitled "The Forest and the Woodsman," courtesy of the Brown Co., was shown. This was followed by another motion picture on "The Downingtown-Mason, Scott Super Cutter." L. E. Smith, Downingtown Manufacturing Co., described the film during its presentation.

James P. Nolan, Oxford Paper Co., gave a talk illustrated with charts, on "How Our Business System Operates." This presentation was based on a series of discussions with plant personnel on (1) how our system works, (2) what it has provided us, and (3) what it means to us. Mr. Nolan constructed four charts during his talk, which was based on the following themes: our American business system, accomplishments of our system, the importance of competition, and individual freedoms under our system. Emphasis was laid on the fact that Americans enjoy the highest standard of living in the world. Any changes in our system must increase this standard rather than decrease it. We must be certain that whatever happens to the American system will benefit us in the three roles most of us play: as producers, as customers, and as savers.

Chicago

As previously reported in the June, 1952, issue of *Tappi*, the April meeting of the Chicago Sections was devoted to a panel discussion on surface sizing materials. The papers which were given by Messrs. Kumblad, Casey, Ware, and Vallandigham follow.

Wax Emulsions

Warren Kumblad

I would like to take this opportunity, at the outset, to express my thanks for the privilege afforded me to serve as a member of the panel which will tonight address this gathering of members of Chicago TAPPI. Since the time allotted and available is obviously not sufficient to explore with any degree of completeness, the subject of wax emulsions and their relation to the paper converting industry, we can only hope to stimulate greater interest in the potentialities of this unique group of products and to set the stage for a "question and answer" period which we trust will be most helpful and worth while.

Petroleum wax, as such, is well known to all of us, in such common items as bread wrappers and kitchen rolls, where millions of pounds are consumed annually. Other uses involve the application of molten wax and solvent solutions of wax in the impregnation of papers and textiles, tarpaulins and tenting fabrics being examples of the latter. However, many paper converting operations are not equipped to handle either solvent solutions or molten wax and it becomes necessary, therefore, to employ other means to apply controlled and sometimes extremely small quantities of wax in order to impart certain functional properties to the finished paper.

What are wax emulsions and what advantages do they offer over hot melts and solvent solutions?

Petroleum wax emulsions consist of wax in the form of very small particles, dispersed in water by means of an emulsifying agent. Both of these solid components may vary widely in type and characteristics:

The emulsions may, first, contain paraffin waxes, microcrystalline waxes, petrolatums, or any blend thereof. If a dry, relatively light-colored deposit is required, a paraffin wax emulsion should be employed. If greater toughness and flexibility are needed, a microcrystalline wax emulsion will be found to be more satisfactory. Petrolatum emulsions may be expected to impart both flexibility and softness to the papers or stocks in which they are employed.

Emulsifiers, used to stabilize emulsions, may be anionic, cationic, or nonionic in nature, depending upon the end use or the type of system in which the emulsion is to be used. It will suffice, at this point, to note that wax emulsions may be acid stable; i.e., resistant to breakdown in the presence of alum or hard water, or nonacid-stable, the latter type being precipitable with alum, as is rosin size.

Second, wax emulsions offer the following advantages in application:

1. May be handled and applied at normal room temperatures.
2. Contain approximately 50% solids. Most solvents will dissolve only 10% of wax.
3. The dispersion vehicle, water, is nontoxic and noninflammable.
4. Do not require solvent recovery systems.
5. May be applied to water-wet materials, thus, in some instances, eliminating one drying operation.

In papermaking operations, wax emulsions are normally employed at three points:

STOCK BEATERS

Wax emulsion, diluted with from 3 to 20 parts of water is added to the stock in the paper mill to supplement rosin size or to replace from 20 to 40% of this material.

The use of wax emulsion at this point will result in the following benefits: (1) improved sizing and water-resistance, (2) a more desirable finish, (3) improved printability, (4) greater softness and pliability with consequent improved folding characteristics, and (5) reduction in curl of cut sheets.

In order to achieve the above results, it is necessary to employ only from $^1/_4$ to $^1/_2$ of 1% of wax emulsion, based on the weight of pulp fiber.

Because of the great total surface of fiber which must be covered, small particle size and the resulting greater distribution of wax are important. Wax emulsions, properly prepared, possess this property. While this method of wax application obviously does not completely fill the voids between fibers, as does hot wax impregnation, the effect produced is analogous to that observed when a wire screen is lightly coated with oil or wax. While openings in the screen still remain unclosed, water passes through with great difficulty.

Since the pulp stock in the beater usually contains acidic constituents, it is recommended that acid-stable emulsions be employed, in order to prevent premature precipitation of wax with resultant increase in particle size.

Stock for the following grades of paper may be advantageously treated in the beater with wax emulsions:

Wallpaper—Improved drape and finish
Map paper—Water resistance, drape, and fold
Poster paper—Water resistance
Wrapping papers, particularly butchers'—Water resistance
Tablet paper—Curl
Envelope—Fold and resistance to feathering
Offset—Curl and improved printability, the latter because of reduced surface "fuzz"
Drinking cup (hot coffee)—Water resistance at high temperatures

SURFACE SIZING

Surface sizing refers to treatments which deposit materials on the surface of papers rather than internally as discussed above. This type of treatment serves to concentrate the active

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component of the emulsion on the outside of the sheet in a more or less continuous film, thereby imparting special properties. Such applications are usually made by one of the two following methods:

Size Press. An integral part of the paper machine located within the drier section and consisting of means for applying wax and/or other dispersions to both sides of the paper. A sufficient number of driers follow this operation to permit complete removal of water from the sheet. When this method is employed wax emulsions are very often used in combination with various types of starches. However, wax emulsions may be used alone, in which event they should be diluted with from 5 to 25 parts of water.

Since most papers at this point contain residual alum or soluble electrolytes, which will, in contact with aqueous coating compounds, tend to leach out, acid-stable emulsions are, again, recommended.

Paper sized with wax at the size press include:

Candy cups—Increased slipperiness, for rapid filling
Meat wraps—Water, blood, and grease resistance
Bag stock—water resistance
Spinning paper—Softening, lubrication, and improved twist
Chart paper—Drape and fold
Bristol board—Improved finish and water resistance
Folding boxboard—Water resistance and plasticization of starch
Corrugated liner—Improved printability and water resistance

Calender Stack. The properties imparted by wax which is applied at the calender stack by means of a water box are similar to those obtained at the size press, in that surface treatment is involved. Since, however, the sheet may not, in this instance, be further dried, the calender method is limited to the heavier, board-type papers, which carry a considerable quantity of heat into the wound roll, where some drying will take place.

The following grades may be surface sized at the calender stack:

Board liners—Water resistance, finish, and printability
Wallboard—Water resistance
Tag stock—Water resistance
Bottle cap—Water resistance and moldability
Match stock—Lubrication for cutter knives
Butchers'—Water, blood, and grease resistance
Boxboard—Same as for size press applications
Corrugated liner—Same as for size press applications

While the methods described above may be employed for the treatment of many other grades of paper, we would suggest that such might better be discussed at the close of the meeting, during the period set aside for that purpose.

We believe it should be pointed out, here, that the methods employed for the surface treatment of papers, during manufacture, may also be employed by paper converters, as a separate and distinct operation.

At the risk of appearing to intrude into other realms, we might suggest that wax emulsions may be used, in small quantities, as modifying agents in combination with some of the materials which will be discussed by other speakers on this panel. We shall attempt to be prepared for any rebuttal which might follow.

Paper converters are, we believe, employing ever-increasing quantities of rubber and resin latices in the surface treatment and impregnation of many specialty grades. Wax emulsions, when incorporated in such latex systems to the extent of 3 to 5%, based on the weight of the latex, serve to reduce tack, improve appearance, and minimize the deleterious effect of sunlight, ultraviolet, and ozone on surface-coated papers.

In conclusion, it might be said that wax emulsions as now constituted or as might be compounded for special or unusual applications are capable of imparting many desirable and functional properties to paper and paperboard. Of primary importance, in the selection of the type of wax emulsion to be employed, is a determination of the characteristics desired in the end product and the conditions under which the emulsion will be employed.

Starches

James P. Casey

I WAS asked to speak briefly tonight on the subject of starch. I was further asked to treat the subject from the standpoint of paper converters, rather than from the standpoint of the paper manufacturer.

Paper converters and users of paper are interested in one thing—will the paper do the job it is supposed to do? It doesn't matter whether the paper contains starch or any other specific material as long as the finished paper has the desired properties. Certain advantages are derived from knowing the composition of paper, and some consumers make a practice of routine chemical analysis. While this is generally laudable, there are certain pitfalls in this practice if one tends to base his opinion on how well a paper will perform solely on the chemical composition.

Starch can be detected in paper by the very simple and very sensitive iodine test. Quantitative analysis is more difficult, but the test method is well known and widely used. However, neither the qualitative test nor the quantitative test for starch in paper tells what the analyst really needs to know. For example, it does not tell whether the starch was added by calender application, by size press or size tub application, or by beater addition, or, for that matter, whether the starch is present by virtue of having been present in wastepapers used as raw material in the papermaking process. Neither do tests for starch tell anything about the type of starch which is present—that is, whether it is corn, waxy corn, tapioca, potato, or any of the other common varieties. It does not tell whether the starch is unmodified, oxidized, enzyme converted, or dextrinized. And these are only the traditional types of modified starches, and do not include any of the newer modified types or the starch derivatives. For cornstarch alone, there are perhaps a dozen or more basically different types of modified products and literally hundreds of variations of these different basic types. Furthermore, I am sure that modern chemistry is going to open up entirely new and extremely useful forms of modified starches and starch derivatives. All these different forms of starch and the different ways in which they are commonly applied to paper produce different results, and the main point I would like to make is that it is very inexact to lump them all together in one classification. Some people have obtained misconceptions about starch and what it will do by drawing conclusions from only one type of paper known to contain starch. Such fallacious reasoning should be avoided with all substances, of course, but it is most likely to happen in the case of starch since starch is readily detectable and is commonly tested for in paper, and yet many people are not aware of the many ways in which it can be present which affect the results obtained.

A wide range of effects can be obtained by choosing the correct starch and the proper method of application. For example, any desired degree of gloss ink resistance can be obtained; the strength of the paper can be greatly increased (except for tear); surface fuzz can be eliminated; erasure can be greatly improved; writing qualities greatly enhanced; and other desirable effects obtained. All of these effects can be obtained at a very low cost to the papermaker.

Starch will not do everything, of course, and like every other substance, it has certain inherent features which we wish we could improve. One of these is the inability of starch to produce films which will retain their flexibility under all conditions. This inherent disability makes it impossible to produce films of starch on paper which are completely continuous under all conditions, and which will retain their conti-

JAMES P. CASEY, A. E. Staley Mfg. Co., Decatur, Ill.

nuity even when the paper is flexed. This is not as much of a disadvantage as it might seem since an absolutely continuous film of starch or any other material on the surface of paper would probably make the paper far too impervious to printing ink to be satisfactory for printing. Starch is eminently satisfactory for surface sizing as attested by its extensive use for the calender sizing of paperboard for gloss ink printing and for the surface sizing of bonds, ledgers, offset, and similar papers. We would, however, like to know how to make better films from starch for special uses, such as for making oil and greaseproof papers which, so far, has not been done with complete satisfaction.

It should be pointed out that starch is used as much for its adhesive qualities as for its sizing qualities. Generally speaking, starch makes a very satisfactory adhesive. I am using the term adhesive in its broadest sense to include not only the actual laminating of two or more sheets of paper, but also the use of starch in pigment coating where the starch bonds the pigment to the paper, and also the use of starch in surface sizing applications where it serves the function of bonding the fibers together in the paper. Most paper manufacturers surface sizing with starch whether at the size press, size tub, or calender stacks attempt to get a certain degree of penetration of starch into the paper to increase the fiber bonding. Thus, when properly done, surface sizing with starch accomplishes two things: (1) it controls the oil and ink absorption properties of the paper so that the paper has the correct ink receptivity and ink hold-out, and (2) it controls the surface and internal fiber bonding so that the paper has sufficient resistance to picking and other stresses during printing. Thus, starch serves to control two characteristics of the paper of great importance to the printer.

The purpose in this short talk was to emphasize the very simple thought—which is probably apparent to everyone—that we should not make a simple qualitative test for starch in paper and use it as a basis for any preconceived notions of what the paper should or should not do. Most grades of paper contain starch in some form. If we want to analyze for starch, we should try to obtain as much information as possible on the quantity, distribution, state, and type of starch which is present.

Sodium Alginates

V. V. Vallandigham

Sodium alginate is a derivative of alginic acid which we obtain from kelp harvested off the coast of San Diego. And that is just about as technical as I am going to get with the chemistry of the alginates. I might add this that they are physically in a group known as hydrophilic colloids. Those materials are solutions in every sense of the word with the exception of one and that is their high degree of resistance to filtration. In order to demonstrate that function to you I have a blotter here which I would like to use and will place a 1% solution of sodium alginate on it. I would like to start this at the first part of this discussion because we can then examine it when we have finished talking. We will add this to the surface of the blotter. We must remember that the blotter is designed with all the papermaking know-how to absorb. We will add a little water to that. You can readily see how fast it will take it up.

This will give the basis for which we use and apply these materials to the surface of the paper. All of which have a much higher degree of resistance to absorption than does the blotter.

Here we have a 1% solution of algin. There has always been question as to whether the wetting agent is in the water so I am going to drop that down to half a per cent. We will place this up here and let it set. Set this other one up here. Those of you in front will notice something else. The solution readilly wetted the surface. The solutions are polar. They readily attach themselves to cellulose fibers.

All absorption formation, smoothness, and picking are factors affecting printability. All of these characteristics have to do primarily with the sheet surface and it is with the surface of the sheet that has the greatest influence on printability that we are going to deal. Our discussion is to be confined to the treatment of the sheet after it has been formed. Therefore, we will discuss the application of various sizing solutions to the surface of the sheet to obtain the most desirable characteristics for printing and waxing.

The most effective and economical way of controlling the surface qualities of a sheet of paper or paperboard is by application of special sizing to the surface by means of (1) calender stack water boxes or (2) size presses. Paper can be manufactured without the use of these types of units to give any desired degree of oil or water resistance. However, it is generally too costly to do so. The use of either the calender stack or the size press for the application of surface sizing gives a greater degree of flexibility and permits greater tolerance of the paper or paperboard to be sized. In addition the cost of such treatment is much less than is a special preparation of pulp to obtain the characteristics.

There are two types of surface sizing. They fall into two major classes: (1) The saturating type such as the starches and low viscosity materials which bring about the desired result by filling the air spaces in the sheet. I believe that Mr. Ware pointed out the spaces between the fibers as they are formed and it is the same spaces we are discussing here. Sizing with this type of material is generally costly because of the high consumption of size due to saturation. This method, however, can be used to increase the burst and pick and increase the internal density of the sheet. (2) Then we have the filming type which has a great deal to do with your printability. As a matter of fact it is probably most effective with regard to printability. Filming types are of highly polymerized material such as algins which are selected specifically for their film-forming characteristics. This type increases the surface density thus controlling the absorption of printing inks, waxes, oils, varnish, and similar materials. Consumption of this type of sizing is lower and efficiency is greater than the saturating type.

It is frequently desirable to make combinations of these two sizing types to develop characteristics of both. A film-forming type of sizing, such as algin, may be added to a low viscosity starch in high concentrations, and the film former will contribute filming properties to the low viscosity saturating sizing. This allows the use of relatively concentrated sizing solutions to produce films of extreme high density. This type of sizing is applicable for the production of waxing sheets such as bread wrap, milk bottle, butter carton stock, carbonating uses, and wax laminations. This method may also be used as a presize for stock to be clay coated. Algin has obtained acceptance as a surface control sizing in the paper industry because of its characteristics in producing special effects on the sheet surface.

The range of viscosity permits effective usage in the specialized sizing application previously mentioned. Algin is readily adaptable to water box application as it is soluble in either hot or cold water, does not cause foaming, picking, sticking the sheet to the calender rolls, or filming of the calender rolls. As the algin film lies almost entirely on the surface, curling is reduced and in some cases can be eliminated. These characteristics allow for a uniform application of the film upon the sheet surface. Algin helps lay down the surface fibers of the sheet, and as a result the surface is smoother, and the gloss is increased.

Different types of algin are available to produce the desired type of surface sizing on the various productions and equipment conditions. Effective control of printability is obtained by the application of 1 lb. of algin to approximately

V. V. Vallandigham, Kelco Co., Chicago, Ill.

60,000 sq. ft. The mileage depends mainly upon the freeness and the texture of the paper surface. In recent years a satisfactory method has been developed for the rapid evaluation of the resistance of paper or paperboard surfaces to mineral oils. This has been found to correlate well with actual printing and waxing results and is based upon the change of gloss with time with a uniform oil film spread upon the paper surface. Now I would like to take this opportunity to draw a few curves and give you a brief description of the instrument of which we talk. It will be the basis upon which we will give you the readings of the sheet we are to examine.

This is the curve representing the oil absorption into a surface of paperboard. It is very difficult to detect the algin content by analysis or any chemical device. We can check the effect of algin on the surface but if you have a pound of the material covering some 60,000 sq. ft. the quantity is so small that we have to determine the effect. We worked out a device where we cast a thin film of oil on the sheet surface, cast a beam of light on the oil, and pick up the reflection in a photoelectric cell. Now as the oil remains on the surface you will have a gloss reflected from the oil itself. As that oil penetrates naturally you would lose the gloss reflected from the oil because it was no longer on the surface. Therefore, the oil penetration into that surface is in direct proportion to the loss of light which is in direct proportion to the rate of or at which the oil will go into the surface. We represent that here by determining the light in microampere readings and check it out against time in seconds.

For example, if we had a sheet that would resist all penetration it would remain at a 100% reflection. We would have a curve that would continue as a straight horizontal line over an infinite period of time. That would be a sheet of complete greaseproof. If we had a sheet where the curves would drop off in 0 sec. it would be like a piece of newsprint or blotter. Therefore, we have the two extremes and everything in the way of paper to be used to print would then fall between 100% greaseproof, or zero penetration, up to 100% penetration.

We have found by 8 to 9 years of continual testing with a Vancometer that we can express a curve by taking a reading at the end of 20 sec. We call that our printability number. With this sheet we would have a printability of 75 or a pretty fair gloss ink range. Now there are quite a number of these instruments in use and we have compiled quite a bit of data. As a result we have been able to correlate the oil absorption factors in the sheet to the printability, and we now can predict what a sheet will do with reference to printing before it comes off the paper machine. If he requests a gloss ink sheet, you can determine in a matter of 20 sec. what the printability number is and set it at that particular figure. If the sheet does not meet the specifications it is absolutely senseless to continue on producing more paperboard because regardless of how many tons you make it still is not going to meet specifications. Likewise, if the printer uses the device to check paper as it comes in, they can determine in advance whether that sheet falls into the proper printing quality or if it does not. They then know what to do.

Out at Ace Carton they have done, to my knowledge, the most complete job of correlation between paper production and printing. They are able to predetermine the printability of any particular order. Now I have seen sheets that they have been able to print and obtain a good gloss which are well below the gloss specifications that we would recommend for normal operation. That is because they have been able to treat the ink in such a fashion as to compensate for the lack of printing quality in the sheet as delivered. That is something which I think should only be used when you are right up against the wall and there is not anything else that you can do about it. You take your caliper, you want a 16 point and you know very well you cannot deliver a 12 or a 20-point sheet and get away with it. They want a certain brightness and you must deliver that specification. They want a certain burst, they want some tear tests. You have tests by which you can rate and know definitely whether that sheet will fall in that particular specification. Printing quality is just as important and probably more important when you consider the fact that the end consumer of that particular sheet is probably an individual who has not the vaguest idea of what a G.E. brightness test is, what a caliper looks like, or any other testing device. It is the housewife who picks up that particular sheet off the shelf as a soap carton and it either looks nice or it doesn't look nice. She is the final consumer and the one who will eventually reject that sheet. If there is enough of those boxes sitting around at the end of a week's time, the complaints go all the way back.

It was very gratifying last week when working on a mill in the South and the technical director said, and I have been waiting a good many years to hear this, "You know we have come to the conclusion that printability of a sheet is the most important characteristic we can develop."

I have a set of sheets here which were run recently in a mill in which they wanted to develop a greaseproof bakery carton. The prime requirement was to resist oil penetration. They were using a regular saturating type of size at a concentration of 10%. They applied that size in a calender box and they obtained a Densometer of 400 sec., a turpentine resistance of 10 sec., and a Vancometer of zero penetration for 10 sec. To that sheet we added 0.6% algin and reduced the solids of the original sizing by 5%. Now remember the surface has no depth. It has two dimensions—length and width. We are not talking about 1 ten-thousandths depth or 2 ten-thousandths or 10-thousandths or any other figure. We are talking about zero depth and length and width. That constitutes surface. If we can concentrate a higher degree of solids at the surface we then can make a much more effective film for resistance against oils and waxes. This same 0.6 material added to half of the original saturating sizing raised the Densometer from 400 to 1440 sec. The turpentine resistance was increased from 10 to 120 sec. The Vancometer read 100% zero penetration for 3.5 min. as against 10 sec. We then took one of our lower molecular weight algins, at a 1.5% concentration added to 5% of the saturating sizing and raised the Densometer to 2640 sec. as against the original 400 sec. The turpentine went to 210 sec. as against 10 sec. and the Vancometer went to 7 min. resistance at zero penetration. You can very readily see the degree of resistance to penetration. Now this blotter has been sitting here since we started our discussion. The 1% algin is still sitting on top of the blotter, showing no penetration. We have some wetting on the other side. Now this algin concentrate will still be sitting here when we go home tonight and when they clean off the table tomorrow.

We have a set of printed samples, all of which will demonstrate the ability of algin to resist penetration. You can see the difference in the color of the ink as a result of penetration. This has the highest degree of absorption and this has the highest degree of resistance—all printed with the same ink or at the same time or within a few seconds of one another—as fast as we could run it through the press.

Here are the same set of sheets on half-tone. I show them for this reason: that you can obtain both good flat ink production and good gloss ink production if you have a perfectly uniform surface resistance. Now that uniformity means that if you want 50% penetration or a good flat ink, that means that you want a 100% of that sheet for 50% penetration. You don't want 10% of that sheet at 90% penetration and another 40% at some other figure. You must have absolute uniformity. And algins can deliver uniform surface films to you for good uniform application.

Carboxymethylcellulose

Harris Ware

CMC is a water-soluble cellulose derivative, also known

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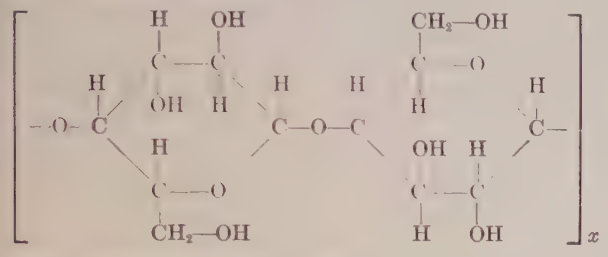
as cellulose gum. It is used in papermaking by both beater addition and surface application at the size press and calender stack. It is also used in wet-packing bond and ledger papers and may be a component of the coating in coated book papers. Since the Chicago TAPPI Section is mainly concerned with converting, I will limit this discussion to the surface application of CMC. Even so, it will be necessary for us to discuss CMC from the point of view of what you may expect from papers that have been treated by the paper mill, for when water-soluble materials are applied to paper, driers are required and the paper mill is generally equipped to handle the drying problem that results.

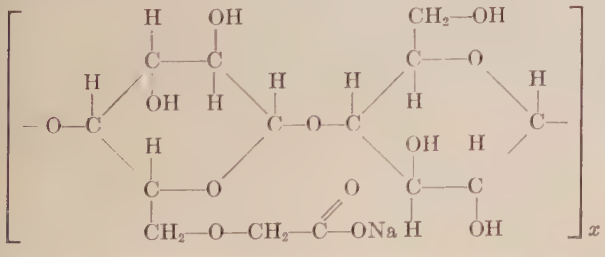
Many cellulosics have been recommended for use in papermaking. In fact the number of chemicals and the number of uses have sufficiently confused the issue that it may be well to define specifically the chemical about which we are speaking.

The basic material from which CMC is made is cellulose. It has a structure like this:



Now, all that looks pretty complicated but all it amounts to is a simple thing very similar to glucose, polymerized into a long chain and named cellulose. In the structure we have shown, two glucose anhydride units are represented. Although one unit would be sufficient for demonstrating the composition of cellulose, two units have the advantage of making it easier to visualize the polymeric nature of cellulose. Many of you are converters and more concerned with the conversion of paper rather than its manufacture. It may be true that this approach to papermaking will appear to you to be somewhat obtuse. You might stop to consider for a moment that many paper technologists must think in terms of this or similar structures in their everyday work with the properties of paper as they relate to alpha-cellulose content, tear, burst, etc. To the chemical manufacturer this structure is interesting because it guides us in the manufacture of derivatives from cellulose.

By converting cellulose with sodium hydroxide to alkali cellulose we have it in a form where it will react with sodium monochloro acetate and form one of a large family of derivatives, thus



As I have shown the reaction, the substituent group went on the primary hydroxyl group in cellulose. You will observe from the formula that there are two secondary hydroxyl groups available which can react with the carboxy methyl group to produce other distinct carboxy methyl cellulosics. As this reaction has been demonstrated to you, only one glucose anhydride unit and one carboxy methyl unit have been employed. Surely you all appreciate that for cellulose containing several thousand glucose anhydride units the reaction is repeated many times for each molecule of carboxy methyl cellulose. Generally speaking the higher the degree of substitution the more water soluble is the derivative and the lower the solution viscosity. In the nomenclature the extent of this reaction is shown by numbers which may vary from 30 to 120. These numbers represent the number of carboxy methyl groups per 100 glucose anhydride units. One hundred glucose anhydride units are employed to simplify the nomenclature when less than one carboxy methyl group is employed per glucose anhydride unit. When you have one carboxy methyl group per glucose anhydride unit it is called CMC-100. When you have CMC-30 it means that 30 of the hydroxyl groups out of every 300 hydroxyl groups have been substituted. Commonly we have CMC-70, which means that in every 100 glucose anhydride units 70 of the carboxy methyl groups have been substituted in the cellulose chain.

An important modification of CMC can be made by altering the chain length of the cellulose independent of the degree of substitution. The shorter the chain length the lower the viscosity. I have three test tubes containing 2% solutions of different CMC's, equal except for chain length. You will observe that though the chemical composition is identical the properties are widely different. This test tube contains a very low molecular weight material somewhere in the neighborhood of 50,000 and it is a very thin solution. Here is another 2% solution of about 400,000 molecular weight and it is very thick, almost a solid gel. Here is a third 2% solution, partway between the first two in molecular weight and partway between in viscosity. The nomenclature for CMC incorporates a viscosity designation.

CMC always has three parts to its name. "CMC" identifies the carboxy methyl derivative of cellulose. The CMC is always followed by a number and this is the number of carboxy methyl groups per hundred glucose anhydride units. The CMC number is always followed by a viscosity designation. Finally we have, for example, *CMC-70-LOW*.

It is an interesting fact that cellulose is insoluble in water and that solubility would ordinarily be expected of a material which was a carbohydrate and contained a high proportion of hydroxyl groups. The insolubility suggests the possibility that strong forces must exist between the cellulose molecules. This same force may function between the fibrils and finally between the fibers making cellulose quite insoluble and providing at least in part the strength properties of a sheet of paper. Further evidence that this bonding force is very high is the tensile strength of cellulose fibers which may be as high as 100,000 p.s.i. Translated to paper the potential strength has been calculated by some authorities to be 30,000 p.s.i. In practice we do well to attain 10,000 p.s.i., thus being unable to account for roughly two thirds of the potential strength. It has been shown by Mark, Ott, and others that the desirable intramolecular forces which could account for the strength obtained operate over very small distances, in the order of 2.5 A. Since cellulose has shown such a remarkable capacity to bond to itself, water-soluble cellulose might be an ideal bonding material. Since no water-soluble cellulose exists, a water-soluble cellulose derivative with the least possible modification from cellulose may perform for cellulose the same job that cellulose performs for itself when it can get sufficiently close enough to do so. CMC is such a chemical. It would seem logical to conclude that if water-soluble gums are to markedly alter the properties of paper, either relatively large amounts of material must be employed or the spacial arrangement of the fibers must be altered beyond that practical on the wire of the paper machine. It would seem that the proper time to treat the paper would be when you had the sheet under considerable pressure such as can be developed in the size press and more particularly in the calender stacks. In effect this type of treatment amounts to pressing the fibers close together and then chemically nailing them there.

For surface treating paper CMC-70 in various viscosities has been employed. Further work with other types may lead to interesting new possibilities. Three facts about CMC are pertinent: (1) CMC is a film former, (2) CMC is insoluble in oils and grease, and (3) CMC is available in a wide range of viscosity properties.

As used by the paper mill CMC is dissolved in water at from 0.5 to about 10% solids. It is applied hot (130 to 170°F.) at the size press and at the calender stack. Using these concentrations of CMC, the quantities applied are approximately 2 lb. per ton on board stock and 5 to 35 or 40 lb. per ton of lightweight offset paper. The amount that is used and the techniques for applying it can better be handled as a mill problem rather than here. The important point is the extremely small amounts of CMC required. Two pounds of CMC per ton of 100-lb. basis board is equivalent to 0.05 lb. per thousand sq. ft., and is such a small volume that you cannot see it on the paper with a microscope.

Such a treatment produces changes in the strength properties of the sheet as exhibited by bursting strength gains of 5 to 20%, scuff resistance gains up to 600%, and Dennison wax up 2 to 6 waxes. The penetration characteristics of the sheet are markedly altered as indicated by porosity (about 100% rise although highly variable), oil drop penetration from seconds to minutes using turpentine, Vancometer increases from the middle twenties to above 70 at 20 sec. Wax penetration is decreased 25% and higher based on wax add-on measurements. Improved resistance to K&N ink is qualitatively observed even in starch mixtures. Perhaps it is proper to qualify these results by stating that the type of paper stock to which the CMC is applied is also an important factor, and since it can markedly influence the results obtained these figures must be accepted with that fact in mind.

Of particular interest in demonstrating the quantitative effect of CMC treatment is the influence of such a treatment on ink mileage. Because many of you men are in the converting end of the paper industry I would like to call your attention to these new data. These data are best treated graphically and if you will bear with me for just a second I will draw these data up here on the board. In the plot we are making, the *Y* axis or abscissa will be the pounds of ink required per 10,000 sq. ft. of board to give a 50% gloss reading using a Hunter 75° glossmeter. The *X* axis or ordinate will be the CMC add-on in pounds per 10,000 sq. ft. of board surface. These data we have plotted are:

X	*Y*
0	23.5
0.1	17.1
0.2	15.6
0.3	14.7
0.4	14.15
0.5	13.7

These data may be interpreted in this way; in order to obtain a 50% gloss on untreated folding boxboard it required 23.5 lb. of ink. The same board treated with 0.3 lb of CMC requires only 14.7 lb. of ink. Here 0.3 lb. of CMC produced an ink saving of 8.8 lb. Let's assume the value of the ink was $1.00 per lb., that's equivalent to savings in ink of $8.80. Now let's consider the cost of the CMC treatment using 0.3 lb. of CMC at approximately 60¢ per lb., it is 18c. To this CMC cost must be added the operating costs of applying the CMC to the board. Even so, the value of the ink savings so far exceeds the cost of the treatment that the new result is an attractive economic incentive in ink savings for the utilization of surface-treated board.

By way of summary, I believe that as time goes along the utilization of chemicals and pressure will become a more important part of papermaking than it has been in the past. Surface treating chemicals will be employed more in papermaking, and the advantages obtained passed along to the graphic arts industry.

Question: What does CMC have that methyl cellulose does not have?

Mr. Ware: There is a difference in the solubility characteristics. CMC is soluble in hot or cold water. It can be handled in water heated to 200 to 212°F. Solubility is influenced by degree of substitution as previously shown. CMC has one other interesting feature although I hesitate to refer to the long-haired chemistry. You will recall from the structure on the board that the substituent group in carboxy methyl cellulose is an acid group and the sodium salt is water soluble. This group is unique because it permits the attainment of solubility with the least modification of the cellulose to obtain the soluble cellulosic. Other substituent groups are less water-loving by nature and to obtain a water-soluble cellulosic it is necessary to go to a much higher substitution and thereby modify cellulose to a greater extent.

Question: You apparently take a somewhat different viewpoint than is common. Is the internal structure of the sheet actually favorably influenced?

Mr. Ware: I don't know what is meant by a different viewpoint than is common. Actually I thought there was an amazing similarity here in point of view. It is doubtful if the internal structure of the sheet is affected. We have tried to determine how far CMC solutions penetrate into the sheet and have been unable to detect CMC below the top liner of a multilined board. From these data and the fact that you are applying such a small amount of solution which can be readily exhausted in partial penetration of the sheet, one would be led to believe that such a treatment is primarily a surface phenomenon. If the material is a high molecular weight polymeric hydrophilic colloid it is going to perform very similar to the exhibit that Vance has made here with blotter paper.

Question: What are the concentrations of the CMC samples demonstrated?

Mr. Ware: I presume the question refers to the concentrations employed in obtaining the data for the curve that we drew on the board. Those solutions varied between 0.75 and 2.25%. The test tube solutions are all 2% concentration.

Question: Do you obtain equal gloss ink results with the reduced quantity of ink?

Mr. Ware: Right. That's the point in fact. Those data that I drew showing ink mileage versus CMC are computed on the basis of the amount of ink required to produce a 50% gloss using a 75° Hunter glossmeter. We happened to select a 50% gloss because it corresponded to the gloss that was being obtained commercially for the particular printing job employing the experimental paper. It is an interesting fact that in collecting the data we found the gloss of the sample was directly proportional and linear to the ink add-on. You might select any given gloss, for even on nongloss printed board you can obtain a 50% gloss with sufficient ink add-on. The difference between gloss ink board and nongloss board is that on the nongloss board it required 25 lb. of ink per 10,000 sq. ft., and with board treated for gloss ink printing it required approximately 40% less ink. With the extra ink on the nongloss treated board you have added operating problems in handling that volume of ink and in filling half-tone plates.

Question: What is the cost per ton of CMC-70 for a good gloss ink surface?

Mr. Ware: The amount of surface treating agent that you have to employ, as you know, can be largely influenced by the type of paper to which it is applied. For example, if you have a well-beaten sheet that has a very smooth surface you might obtain a satisfactory print job with as little as a quarter of a pound of CMC per 10,000 sq. ft. of surface. If you are considering a board weighing 100 lb. per 1000 sq. ft. there would be 20,000 sq. ft. per ton of board and you could expect to use about 0.5 lb. of CMC, equivalent to a material cost of 30¢ per ton. On a very free sheet more material would be required. For a single figure, something in the neighborhood of 0.05 lb. per 1000 sq. ft. times 60¢ per lb. will yield the approximate cost of materials. To this must be added the operating cost of preparing the solutions and applying them on the paper machine, and this is a matter which I believe you can compute better than I.

Question: How do the tensile strengths of CMC films vary with humidity, particularly in the 10 to 50% range?

Mr. Ware: We know that the tensile strength of CMC films, depending upon the viscosity type, are somewhere in the neighborhood of 10,000 to 14,000 lb per sq. in. but I don't recall at the moment how that figure varies with humidity.

Question: Is the cellulose–CMC–cellulose bond more sensitive to humidity changes than the cellulose–cellulose bond in ordinary paper?

Mr. Ware: That is a very good question and I am sorry I cannot answer it. It would be very difficult to measure. I am hopeful that sometime in the future we will be able to answer such questions. At the present time the cost in money and man power of testing these papers under standard conditions is sufficiently expensive and I consider myself fortunate in being able to bring to you the data at one humidity for the graph which was drawn here on the board a few minutes ago.

Question: What do these agents do to the tear test?

Mr. Ware: It depends upon how well the paper is beaten. If the beating condition left in the sheet a large portion of the po-

tential tear these agents will have a power substitution value and increase the tear test. If the sheet has already been beaten to roughly the limit of its beating capacity the tear will decrease as a result of surface treating.

May 19th Meeting

The speaker at the meeting of the Chicago Section which was held May 19, 1952, was Alfred P. Haake, Mayor of Park Ridge, Ill., and nationally known economist. His talk follows:

What Is Ahead for Business?

Alfred P. Haake

IT CALLS for some temerity to talk to a group such as this on what is ahead for business. I am not the son of a prophet nor was my father a prophet. And I have learned in Park Ridge that a prophet is not always honored in his own country. I would not presume to foretell just what is going to happen, but there are some trends and factors at work in our economic situation which are worth giving serious consideration, and from which we may draw some important conclusions.

In the first place, we are in a political year. Normally, that means an uncertain outlook. There was a time people would predict that if the Republicans won we would have good business and that if the Democrats won we would have poor business. There was truth in those predictions at one time.

Then somebody got the crystal ball mixed up and since then, you just cannot tell. For that matter, there has not been a sufficient variety of party in government that it would mean anything anyway. We have begun to develop such complete government control and influence over business, that an administration can almost, if it wishes to do so, adjust conditions so as to keep itself in power.

Thus, some Republican might accuse the present administration of having engineered the Korean war or "police action" some time ago, deliberately in order to avoid the consequences that would otherwise have followed development of the so-called "Fair Deal." No one can prove that, one way or the other; it might have been good or it might have been bad. We did go into Korea after we had pulled out and in consequence of that and getting excited about what might happen in the future, we have put a lot of people to work making war goods. We have set up a feverish kind of activity in production which passes for prosperity.

It you talk to the right people in Washington there is an occasional lifted eyebrow if someone even questions that prosperity. You'll be asked if there ever was a time when we had more people at work, at such high wages and standard of living, and reminded that the economic consequences of the administration policies have been wonderfully good for the people of the United States.

Of course, people who would like to correct the mistaken policies and harmful trends may point out, as I would be inclined to do, that this is a false prosperity; that it is built on an unduly high government debt, a tremendously inflated and even prostituted monetary system. In time, and perhaps not too long, we are going to meet the sheriff and have a reckoning on the deal.

But the interesting thing is that nobody really knows. I'll say to you candidly that I am not too sure. While teaching money and banking thirty years ago, I knew positively that there was only one sound theory of money, the commodity theory of money. I still believe that. I believed then, and still suspect, that the "Quantity Theory of Money" was largely bunk and that anyone who played with so-called "fiat money," money that passes on fiat of the government that it must be accepted in payment of goods and services, was playing with fire and standing on the edge of a precipice. I was convinced that the only way to maintain a sound monetary basis for economic conditions was to have a currency based on gold redemption. If you did not redeem in gold, Gresham's law would begin to operate and there would soon be two price levels, one in gold and one in the unredeemable money.

Well, we came into 1933 and 1934, and a man came into the back door of the White House to sell Mr. Roosevelt the idea that the way to have prosperity was to put a lot more money into circulation so there could be greater purchasing power to hold up prices and employment.

In spite of the fact that Mr. Roosevelt had promised to reduce governmental expense by at least 25% and had made other utterances on sound money which would have satisfied even a commodity theorist during the presidential campaign, after Professor Warren got through with him, Mr. Roosevelt was pretty much of a quantity theorist, sold on the idea that the way to get more prosperity was to give Mr. Roosevelt the power to inject several billions of new dollars into circulation.

So the Federal Reserve Act was modified and the Federal Reserve Bank given the power to rediscount government notes as well as commercial paper, thus making the bank a market for government bonds and vastly increasing the power of the government to issue money for a huge spending program.

The interesting thing was that after the gold prohibition law was passed, which denied the people the right to own gold for monetary purposes which frightened some of us very much, and after the Suprene Court of the United States all but frankly admitted that the law was unconstitutional, the justices decreed that the law was expedient and should be approved. Then, oddly enough, those of us who were commodity theorists failed to see our predictions come true. Gresham's law did not apparently operate and there was only one price level, except in the occasional black markets.

We were a bit dazed, and are yet, trying to find an explanation for the failure of what we know should have happened. But, out of the use of the Federal Reserve Bank to create money for the government instead of going into the open market to borrow the money, came a tremendously significant thing. We now have more than a hundred billion dollars of money in circulation, and the purchasing power of the dollar has been decreased to less than one half of what it was when the program of New Deal spending began. It is the greatest inflation our country has yet known and even our moral standards have been affected by the deluge.

If you listen to a person like myself, you could easily get the idea that we are in for a difficult time somewhere ahead. If you listen to someone who disagrees with the position that I take, you would get the idea that after all, our situation is pretty healthy, and a bit of inflation is a good thing. This inflationary period of ours hasn't gone very far yet, and a lot can happen before possible disaster is expected.

But we can't get away from the fact that the consequence of the New Deal monetary theory has been to tremendously inflate our currency, and very much decrease the purchasing power of the dollar. It has destroyed billions of dollars of savings—it has made insurance policies worth a great deal less than they would otherwise be worth.

In the meantime, we are apparently trying to avoid the consequences of those economic policies by continuing with the inflation and piling up more debt. Let me illustrate that, if I may, with a little story:

My grandfather, my mother's father, came from Michigan to Chicago a good many years ago. They had a lot of kids in the family—too many kids and not enough food. So a couple of the older ones got pushed out of the nest.

Grandad was one of them. At twelve years of age, he came to Chicago, found a home, and went into the hardware business as a clerk. The story is one that could be told of thousands and thousands of American boys. In time he

came to own his own hardware store, had three houses and lots, and a wife and eight kids, and was worth about $50,000. Fifty thousand dollars isn't much today—it's a mortgage on one of your houses maybe—but in 1871 $50,000 was a fortune. At 6%, that paid $3000 a year, and you could live like a king on $3000 a year.

Then, in October of 1871, he got in a stock of goods for the fall and Christmas trade—about $26,000 worth—wasn't paid for yet. And then came the Chicago fire. I don't know how true the story is. You've read it, of course: that a lady by the name of O'Leary came home late one night. She perhaps had been playing canasta all afternoon. At any rate, she came home too late. When she got to milking the cow, the cow was a little bit recalcitrant, and kicked the lamp over. The lamp set the barn on fire, and that set other buildings on fire—and when the party was over, Chicago was a heap of ashes, and grandad was broke.

He and his family found shelter and food after awhile, and he started over again. Chicago picked herself up out of the ashes, and became a great city. But at the moment, grandad owed $26,000. What would he do? A lawyer friend came to him and said, "Joe, what are you worrying about? You haven't got anything, everything is gone. Give it to your creditors, let them have it. Go through bankruptcy."

Well, I suppose he was tempted to do it, but that peculiar old duck had the strange notion that when you owed money you ought to pay it. Think of it! Not because the law made you, but because it was the honorable thing to do. So he signed notes with interest at 8%. It took him a long time, but he got them paid off in time. And then he had his wife and eight kids still. Now he had his hardware store, five houses and lots, and the year he paid them off he had an extra dividend in the person of myself as his first grandchild.

That was 29 years before the turn of the century. It's odd how things repeat themselves in families, even as in history. Twenty-nine years after the turn of the century I found myself broke and heavily in debt. Like my grandfather, I was tempted to go through bankruptcy, and then my wife reminded me of how proud I had always been of that glorious old grandfather of mine. She said, "We'll have grandchildren some day, and after you and I are gone, one of those kids will say that maybe the old man didn't amount to much, but he did pay his debts." That settled it—so I signed notes with interest at 5%. It took us ten years, eight months, and seventeen days, and I could almost tell you how many minutes, until we got it all paid off. But we got it all paid off!

And then I thought I was smart, but now I'm not so sure. A couple of years ago, a fellow by the name of Foley came to Chicago from the Treasury Department—made a speech here in Chicago, reminding us that we had a tremendously high national debt. I took some encouragement out of that—to have anyone from Washington admit that 250 billions was a lot of money—some of the boys haven't found it out yet—but then he went on to reassure us. He said that after all, we needn't worry because while 250 billions is a large amount, and now I quote him word for word, "It is a tremendous investment to assure the security and well-being of our country."

In short, what had been a liability, a debt, had become an investment, and the way to assure the security and well-being of the country was to go deeply into debt.

I never could understand that at all. I'm still naive enough to believe that a debt is a liability. But maybe this is a way to understand it. If you don't mind, suppose you owe me $2000 for just a few moments, and I'll owe you $2000. Now the other fellows here would say that since we owe each other $2000, the sensible thing is to cancel the debt, and call it square. But that's horse and buggy stuff. I'm not going to do that. I'd like to get rich. You owe me $2000, so I'm worth $2000. I owe you $2000, so you're worth $2000. Two plus two is four—and the total wealth is $4000. Now instead of being so foolish as to pay it off—why not get rich? Will you owe me $10,000? And I'll owe you $10,000. Now the total wealth is ten plus ten or $20,000. And if the rest of the boys feel a little bit envious about that, you and I might traipse down to the Federal Reserve Bank, and if we can persuade those fellows our notes are good commercial paper, we might get them to rediscount them and issue $20,000 of 10, 20, and 50 dollar bills against them, then we'll pass it out among the fellows. And now the total wealth is ten plus ten plus twenty, or $40,000.

Isn't that a lot better than paying off the debt? We have become rich by the simple process of going more deeply into debt.

Well, you now know, as silly as that sounds, and I think this has some significance, that is the basis of a good deal of our current prosperity.

Whether or not the current prosperity stands up and is maintained or inflates even greater and then collapses, I suppose, will depend on whether we can do what a lot of people tried to do in 1929. I remember in 1929 making the statement that the stock market would be a harbinger of good omen, a harbinger of greater prosperity *if* we could build up a sound balanced economy to support that stock market structure before the thing went to pieces. Well, it went to pieces before the undersupport was built. And I will say now, that if between now and the time that there is danger of enforced liquidation to correct the overexpansion, we build up a sound economy underneath our present structure of aggravated debt and inflation, then the disaster might still be avoided. But there it is, an impending catastrophe hanging over our heads.

The thing that worries me, even more than the *amount* of that debt, is the change in attitude toward the debt. That isn't an economic factor; it is a moral factor. But it goes hand in hand with a deterioration that is showing itself in many directions.

For example, a good friend of mine, an economist, takes the position that we ought to discourage the discounting of notes at commercial banks for the purpose of expanding currency to take care of current increases in commercial and industrial needs, because those notes have to be paid off. To be sure, you discount a note at a bank, for the time being the deposit credit you get is added to the total money structure, and you have expanded the currency to take care of a need at the place, for the person, at the time when it is needed. But it has to be paid off, and when you pay it off, the currency shrinks again. Which, of course, we commodity theorists think is wonderful because we want an elastic currency that adjusts itself automatically to the changing monetary needs of commerce.

My friend advocates instead that when we need more money in circulation, or think we need more, we have the government go more deeply into debt and monetize the debt, which is a way of saying that we shall solve the problem of inflation and overexpansion by doing still more of it. When the money isn't buying enough, put enough money in circulation, so that wages go up still more, prices go up still more, and, while we have lost the savings of the past, we can build more savings in the future.

You see what is really being advocated there is to meet a difficult situation of a debt which ought to be paid off, not by making the necessary sacrifices, not by doing the necessary work and going through the self denial to pay it off, but instead to take what seems an easier way, namely, change the definition of debt. In that way we would avoid solving the problem at all, merely by saying that debt which used to be bad, is now good; so we don't have to do anything about it—just go merrily on. We even tell ourselves it's all right because we owe it to ourselves. And that is one of the funniest of them all.

I don't know whether you figured that one out or not; I tried to figure it out this way:

Suppose we fellows among ourselves took all of the national debt (that may be a little optimistic as to your buying power) suppose that we did, and it took every penny that we owned. We sold everything that we had, took all our cash, and invested it all in government bonds. Then someone says to us, "But you don't need to worry—it does not matter how large the debt is, because you owe it all to yourselves." It is a comforting reflection isn't it, until you ask yourself this question:

"Since we owe all of that money to ourselves for the bonds that we own, what are we going to use to pay ourselves off?"

You see you haven't got anything left. All you have is pieces of paper. All right! Owe it to yourself! But what will you use to pay yourself? You can't pay yourself.

If you are ever paid, it will be because somebody else pays you. It has got to come out of the difference between the national income and expenditures. If we have a surplus of national income, that can be used to pay it off—but that's the only way it can be done.

And to say that we owe it to ourselves comes awfully close to being cruel nonsense. I am afraid that that is one of the directions in which this lessening of moral fiber begins to hit us!

Another one—if I reached into your pocket and took out 8 dollars and 42 cents, if I'm not too optimistic, that would be stealing. I had no right to take it out of your pocket. There is a commandment that says, "Thou shalt not steal." But if I get a guy with striped clothes on, and you call him Uncle Sam, to take that money out of your pocket and give it to me, that isn't stealing, that's redistribution of wealth. You see, you avoid the sin by giving it a respectable name.

If I tell you a lie, that is a violation of a commandment, "Thou shalt not bear false witness." But if I'm trying to get myself re-elected and it is necessary for people to believe certain things to get them to vote for me, that isn't a lie; that is simply political propaganda to persuade the public to take the kind of a position that is "in their own best interests." You see the difference?

We used to have youngsters, you and I at least, who worked fairly hard. I never felt too sorry for myself. I came from the wrong side of the tracks, and there were times when we didn't have as much as we would have liked, of one thing or another. When I think of my own kids, who didn't have it too hard, I'm not sure that I envy them at all.

I can remember back when I went to the theater once a month down at the old Criterion Theatre at North Avenue and Sedgwick for 10 cents; sat up in "nigger heaven." Sometimes when we were real prosperous, once every week! That didn't happen often. But we never felt sorry for ourselves. And I think, honestly, one of the finest things that happened to us in those days was that we had to scratch for ourselves. Things did not come easy. But the kids of today, somehow, have begun to get the idea that the government will provide for them, that it owes us a living.

Not long ago, a youngster came in to see me. She brought with her a young man in whom she is interested. He is interested in her. He wanted some advice. Should he go to West Point, or should he go to Annapolis? "Well," I said, "Why go to either one?" I wanted to know how he was thinking. His answer was, "Well, the government runs almost everything now, and will run everything by and by. We are all going to be working for the government then, and I might just as well get on the government payroll in the beginning."

Well, I suggested to him that it was an honorable career to be in the army; one could serve his country well also in the navy. He could do it, even in Washington.

"But," I added, "you are taking a defeatist attitude." He said, "In that way I'm sure of my living."

You see, someone has taken away from those kids the zest, call it speculation, if you like, of adventure, the idea of a risk, taking a chance, perhaps not succeeding. Not knowing what is going to happen has become almost abhorrent to some of them. The challenge that made men out of pioneers a couple hundred years ago apparently doesn't have the attraction that it once had.

The trouble with social security is the fact that the billions of dollars that have been paid in as social security taxes are gone; and as the benefits are paid we have to collect the money a second time in new taxes. And, even so, its payment finally weakens the moral fiber of those who exact it.

Let me mention just one more. When I went to church years ago, they used to preach about the devil. Now, I never put much stock in him. I never met him, except in the aggregate, and there were plenty of people who made pretty good imitations. But I never met the guy himself. Yet they sold me on the idea that if you didn't behave yourself, you would go to some place where you burned, or you shoveled coal all through eternity, and it wasn't a pleasant picture. I was scared a little bit of the devil, and I suppose I tried to be a good boy because I didn't like to go to Hell.

That was overdone. A few people pointed out that if you wanted to go to Heaven you had to have your Hell on earth. If you were unhappy and things went bad, but you bore it bravely, then you would have a good time in Heaven as your reward. Well, there has been a reaction on that, and it may be that we have now gone too far in the other direction.

Not long ago I was talking to a group of ministers. I had made the statement, which I thoroughly believe, that there there is a Creator, a Divine Being whose Will has been implemented in the laws of the Universe and that it is the part of wisdom to learn what those laws are and live in accordance with them.

I believe that the Power that created the world can also transform my life, and that even so poor a vessel as myself can become the vehicle for that power.

When the meeting was over, one of the ministers referred to my statement, and then asked, "Do you really believe that?"

In an eastern city, I talked eight years ago to a group of 22 ministers.

I made the comment that I sometimes had difficulty in reconciling what I heard in the pulpit with what I read in the Bible. I told them by way of illustration that I used to preach, preached my way through Wisconsin as a matter of fact, got $6.00 for one sermon and a reduced rate, two for ten, and in those days anyone who heard me preach had plenty of difficulty reconciling what he heard me say with what he read in the Bible.

When I got through, one of the men challenged me. He said, "Were you inferring that some of us don't believe in God?"

I thought that was pretty rugged, for I hadn't meant it that way. But there was something in his voice that rather nettled me, so I said, "I hadn't meant it that way, but since you put it that way, why yes, that is exactly what I mean. If you men actually believed in God, if you believed that He created the world, if you believed that Power could come into a human life and transform that life, if you believed that even such poor vessels as you and I could become vehicles for that Power, you would rely on it, you would use it. But you don't. You go to government and social devices, to do for you what you are afraid God is either unable or unwilling to do."

Then I thought the heavens would fall. And they did, but not the way I expected.

He looked around at the 21 other ministers, came back to me and said, "Sir, you don't know the half of it. A third of of us don't believe in God, and that goes for this bunch right here."

Not one man challenged him. Now, whether it's a third,

a quarter, a half or a tenth, or less, I don't know. The serious thing is that even in the church the idea has grown away from some of the absolute standards that we had some years ago, in the direction that Unitarianism has taken; and as Earl Browder has very frankly bragged, the Communist has been more successful than any other group in establishing a common front with religious groups, and selling the religious masses on the nonreligious of the Communist.

You see, it goes under the guise of brotherhood, broadmindedness, and getting away from some of the absolute standards.

Maybe it's right, maybe it's wrong, but it's a trend that must be recognized. That same trend takes us in the direction of more and more government control. It makes it easier and easier for people to accept the idea of a government becoming the arbiter of what's right and wrong, good or bad, the government deciding what is best for the people, and then establishing customs, and through the customs determining what people shall believe or how they shall make their choices. And, if you are willing for me to be perfectly frank, it leads in the direction of substituting the State for God!

Now, it's tremendously important, as I see it, to realize that you cannot separate religious freedom, economic freedom, and all the rest of our freedoms. They are all tied together, and when you attack any one of them, you really attack all of them. When we substitute the statutes of the State for the former moral and religious standards, we make it easier for the State to take control over economic life, and in turn, our political and personal affairs.

In the mixed picture before us, we must recognize a splendid achievement. We have greatly increased our productivity over the nation as a whole. That, in spite of the fact that men work fewer hours, that some of them actually, as individuals, produce less per hour, and do not work as hard. That is the result of improved technology very largely, and also the result of something that people do not recognize as much as they should; namely, it is the result of improved management.

Management still has a lot to learn. We are not nearly as efficient as we ought to and can be. But we have made considerable progress in the last 30 years or so. We're beginning to learn how to get people to want to do the things that they ought to do. And, if you want to put anything in the form of a formula, that is it. I have the temerity, in this organization with which I work, in talking to groups of foremen, to tell them frankly that there are many things they ought to know and I try to tell them some of them, but you can wrap them all up in one basic truth, and if you accomplish that, you accomplish the great thing that needs to be done. The foreman needs to get his workers to want to do the things that they ought to do. We are beginning to learn that this is the most important thing that could happen. And there is tremendous possibility of still greater productivity still ahead of us.

At the moment, our inventories are beginning to clam up somewhat. Over the last 18 months, there has been an accumulation of inventories, and in several industries within the next six to eight months. I don't mind telling you that I think automobiles may be one of them, and there may have to be an adjustment in prices. However, I am not afraid of it. I think that the improvements that are coming are going to compensate for slowness in the market, and that particular industry is going to go on and adjust itself.

There may be other industries which do not find themselves in quite so good a position, and it is exceedingly dangerous to advise anyone specifically what to do. For example, in a western city, there are a number of refrigerator agencies, strong competitors. One of them several years ago, looking carefully ahead, came to the conclusion that the market was going to be glutted some day, and did not intend to be caught with a big unsalable stock on hand. So they held their stocks down. Their factory could not deliver all they could have sold anyway, so it was not too difficult to do it. The others loaded up, piled up to the rafters with refrigerators, and found themselves later in a position where they could not sell them easily. The market began to go off, and refrigerators began to go begging.

The one concern which had held off on piling up inventories now found itself where it did not have any excess overhead, did not have to take any licking on stock that it had. But in order to sell anything at all, it had to go into a market that was already glutted by the other fellows, who, in trying to sell their stuff were just cutting the heart out of prices. So he was about as badly off as he would have been had he loaded up. It was one of the most peculiar situations I have met in a long time.

What do you do in a case like that? Well, he's going on the same way, he's trying to adjust his stock to the market as it is, and probably within the next year or two will come out all right. But, if he had loaded up a couple of years ago, he would not be in any worse shape than he is now with respect to sales, now having nothing to deliver, or having to sell whatever he does get from the factory, at a too low price.

The inventory situation may become serious. If the war in Korea comes to a close, then it can be exceedingly serious. However, I would be willing to gamble the opinion, and not be afraid to risk my own money as a stake, that the war will not terminate before the election in November, and is not likely to terminate after the election.

Anyone who thinks that the Russians are really in earnest about this truce business is just kidding himself. They don't want to settle that. Mr. Lenin, long ago, and Mr. Stalin after him, took the very sensible position, from their point of view, that they did not want a war, and did not need a war. What they set out to do is to get the United States thoroughly involved and spend herself to death.

So there is not likely to be any lessening of business because of changes in the foreign situation. I have an idea that for the next year or two, perhaps longer, you'll have the prospect of not getting civilian goods much easier than it is right now. You are likely to have even greater demands for foreign aid. That, of course, depends somewhat on who is elected. If one man is elected from the state that has been pregnant with Presidents a number of times, the chances are that there will be a somewhat earlier termination to the rapid expansion. If the President comes from the southwest part of the country, where the Democrats are working to help nominate a Republican candidate, why you'll have a different result. Just which it will be, frankly, I have no way of certainly knowing.

I suppose anything is better than to have neither a Republican nor a Democrat elected, and let the present regime go on.

I think that as between the alternatives, on the one side, the difference is immediately one of the length of time that that would elapse before there is a correction in the present trend. Regardless of who is elected, it is my belief that the present incentives for business are likely to go on. Although, if I were in business, I think I should watch my inventories somewhat more closely than I had been doing, and would look for ways and means for cutting my costs. Because, certainly, within a few months' time, there is going to be stiffer competition in many, many places, and it is already taking hold in a good many of them.

A tremendous factor in this picture is our national debt. That is a complicated thing, with no easy answer.

Trying to separate the essential facts, here is what that national debt means to me. A constantly growing debt, in times when we ought to be paying it off, using the debt to do still more government buying, means constantly growing inflation. The time is going to come, though no one knows

exactly when, when we'll have to stop this inflationary process. Even the men who now see no way out of it, or who want to go further with it, committing still more sin to expiate that already committed, as when being drunk, the sot takes a nightcap to get sober, even those men will recognize the necessity to stop inflation. And when that time comes, we are going to increase our taxes still further.

Well, how much further can we go with taxes? We may already have gone to the point where government is taking funds that should be plowed back through reinvestment in business, and are already spending our seed corn in Washington, instead of planting it. To the extent that goes on, we are gradually making it more and more difficult, and finally impossible, for industry to replace the machines and tools that keep us productive. We shall find ourselves pushed back to a less productive economy.

Much depends upon the attitude we take toward our public debt. At the moment, the trend of attitude is not good from the point of view of industry. Even as people in Washington admit, the debt is too high and should be reduced. The irony is that we are willing to have the spending reduced, in the other fellow's district.

I spoke not long ago in a southern town to a group of businessmen, took occasion to suggest to them that the reason we have a large national debt is that many communities of people are willing to accept subsidies of government money. The farmer has taken government money, apparently everybody but the paper industry has taken government money! Apparently we are perfectly willing to get the benefit of government spending at the expense of someone else.

I mentioned some of the things that were being done in Washington, California, Oregon, Park Ridge, and other places. The audience cheered me. That was wonderful stuff to tell them. It was wicked for the government to subsidize all those other people. I pointed out to them that when we give the government a dollar for benefits, we get back in those benefits only 48 cents out of the dollar, and that I never could see the sense in paying 52 cents out of my own dollar in order to get back 48 cents, and we had better keep the entire dollar at home in the first place. Then they cheered.

But I made a terrible mistake when I included the T.V.A. among the subsidies financed by government. That was very, very different!

Come up to Park Ridge with me. It's a pretty nice place. We pride ourselves on being a free-enterprise community. We don't believe in federal aid to schools, we don't believe in all these subsidies, and we are familiar with the figures, the 48 cents and 52 cents. But, not so long ago, our own high school superintendent went to Washington with his hands out, and a little later was granted $88,000. Our Chamber of Commerce had a celebration. A friend came from Washington, and explained how he had helped to get the $88,000, and the Chamber of Commerce cheered. How wonderful! Park Ridge had received a grant of $88,000. They were happy and proud over it.

And apparently no one realized that we were adding that grant to the government debt; or if they realized it, did not care. And if it had not been for one man who raised mischief around the place, they would still have, and might keep the money. He drew up a resolution, at their request a little later, condemning the government waste, and with it another, demanding that the $88,000 be returned to Washington.

That is what licks us, in place after place, industry after industry, some of them more than others. In short, what what we have to do is to decide which of two philosophies we want to follow in our national life. Whether we want to encourage the still greater growth of government, which is going on now, or whether we want to restore the principles on which we built this country, encourage individual responsibility and enterprise, and have industry itself undertake the responsibilities of providing against the hazards over which workers have no control, rather than have the government assume that burden for them.

It is not an easy prospect, and I am frankly not too sanguine. I can speak for myself, but I do not have too much at stake personally in the consequences of that choice.

It depends very largely on whether as a people, we are going to have the foresight and the courage to see that what might temporarily be a deflation and an unhappy period, is worth far more than it costs, in terms of subsequent prosperity. It has been increasingly difficult to get people to see that far ahead.

We have been dealing with situations and immediate expedients, rather than with principles in order to solve our situations. I think the time will come when we realize our mistakes. I hope it comes in time to avoid the smash that is gathering.

I am fond of calling attention to Rome. You know the story of Rome, of course. Once the greatest empire in all the world, great because the individual Roman, as a soldier, as a man, as an individual, was stronger than his enemies, was organized to lick all the world—Rome began to go to pieces when power-seeking politicians gave free bread and free shows to win popular support for office. Bit by bit the government did more and more for the people, until her strength was sapped and the great empire destroyed.

You cannot relieve anyone of responsibility for himself, stop him from using his muscles, and still have him remain strong. It is just not in the nature of things. And when the barbarians came down on Rome some 400 years after Christ, they licked the tar out of Rome, not because the barbarians were so strong, but because by that time, Rome was rotten to the core.

Abraham Lincoln once warned us; a great Englishman, a hundred years ago, the historian Macaulay, also warned us, that we would be destroyed from the inside. It was Macaulay who wrote a friend in America predicting that a hundred years later, about the middle of the twentieth century, America would be threatened by barbarians and perhaps destroyed; but not from the outside as was Rome. Macaulay said that our barbarians would come from the inside, the products of our own institutions.

In closing, I want to say something that is a little difficult for men to listen to, and perhaps a little more difficult to believe. I have learned that the answers are not in the field of economics at all. I have found them in the field of religion. You can take any of your problems, whether in the selling of goods, the buying of materials, whether in the supervising of production or sales, the supervising of an office—all of your problems come in the last analysis to what we know as "human relations." It is always a question of getting people to do the right things, effectively, at low cost. How do you get them to do it?

And that problem, the core of them all, reduces finally to the ability of an individual to understand the problem, to have unbiased judgment in knowing what to do, and, finally, to know how to deal with people so as to get them to want to do the things they ought to do.

I do not always trust my own brain. If I can limit or reduce the number of pieces on the board, I can play a fairly good game of chess. But, in other matters, even then, I am not content to rely on my own judgment alone. I do not think there is a man living who could be trusted to that extent. That is why the dictators, or the governments that rely on concentrated powers, and a handful of men to direct them, ultimately destroy themselves or are destroyed. It is why our form of government, built on competitive enterprise, which emphasizes the individual, with all the mistakes that he makes, finally survives and licks all the rest, because we have the benefit of composite experienced judgment. Your competitors do more to help you develop good judgement

than any teacher you ever had. And you do that for each other. In consequence of our competition, we arrive at conclusions and policies that are far more likely to be sound than those imposed on us by someone who sits down and tries to figure out exactly what is right for everyone to do.

That means we have to take a lot of punishment. We must have the stamina to stand up under difficulties. From some source we must find courage, with enlightenment and inspiration.

I have often found myself apparently licked, tired out, bushed, worn out, up against a brick wall, not able to go through and not knowing how to get around it. Somehow, in moments like that I have learned that if one has sufficient faith he can reach outside of himself, and from somewhere comes new strength.

You can laugh at me if you like, for saying that; I just know that it is true. Time and time again, I've gone to bed with a problem, my head so muddled that I couldn't even think. And I've offered a quiet little petition that during the night I be helped to understand and to find the right answer. It doesn't always work—I won't kid you —but more often than not, it does. When morning comes I have an answer. Not always the answer I wanted—because the answer I wanted may not have been the right answer. But I did get an answer.

I cannot prove that to you. I can give the answer that was given by a blind man who had his sight restored in the ancient land along the shores of Galilee. After his sight was restored, his friends, neighbors and relatives, and people who tried to make him say things that could be used against Jesus, badgered him all over the place. At last he turned on his tormentors and gave them the perfect answer. He said, "I don't know what you are trying to say or do. I know only one thing; that, whereas I was blind, now I see."

I am telling you that in the problems you face, no matter how difficult they are, I don't think a man among you can afford to pass up the help you can get from that source. Go to the lives of men like George Washington, Churchill, any of the really great fellows. They won't always put it into words or print, although Goethe once put it very well when he pointed out that the great are beneficiaries of strength beyond their own. George Washington, in my opinion, came to the turning point of the Revolutionary War one night at Valley Forge. The legislature in Philadelphia had failed to back him up, failed to provide the food, clothing, and other needs of the men in that little army. That night George Washington did not know what to do or where to turn. He knelt in the snow, not knowing where else to turn, and asked for help. In my judgment, that was the turning point of the war, and victory came!

I am utterly convinced that until, in industry, business, and all phases of life, men turn once more to the absolute authority of right and wrong, and have the courage, wisdom, and foresight to seek the help, encouragement, and power available there—until we do that, we are not going to get very far in solving our problems.

I don't mean by that, passing the buck and saying "Please, Mister, you solve this problem for me." I mean going there for strength beyond our own strength, understanding beyond our own understanding, getting one's self into that quiet, relaxed frame of mind in which the biases, prejudices, and the tensions can be put to one side, and leave one able to think much more clearly than he could do otherwise.

Give it whatever explanation you like, I think that is where we have to begin. Once we re-establish a sound, moral undergirding for our economic and political life, then I think we are well on the way to have a permanent prosperity, a degree of prosperity that the world at this moment does not even dare dream.

New England

During the Joint Meeting of the Connecticut Valley Division of the Superintendents Association and the New England Section of TAPPI which was held at the Toy Town Tavern, Winchendon, Mass., several papers were presented as indicated in the June, 1952, issue of *Tappi*. Since the publication of this meeting report several of the papers were received and are included in this issue.

Permanent Papers

L. S. Reid

Permanent papers were defined as those papers lasting 100 years or more under all conditions of varying humidities and temperatures. These are papers which are used throughout the world for insurance policies and vital records of all sorts. They are also very durable papers, and luckily a permanent paper is a durable paper, whereas a durable paper is not necessarily a permanent paper.

It was then brought out that the kind of paper which meets these use requirements is a 100% rag paper made from new white, cream, or unbleached stock, properly prepared and run relatively slow on the machine. In addition, it should not have a rosin content greater than 1.2% and a pH of less than 5.0 for white or 4.7 for colored paper. It should be tub-sized with high-grade animal glue and have the requisite strength characteristics, particularly folding endurance. In many cases it should be opacified, and should have good printing qualities and writing and erasing qualities.

The best way to assure the consumer of obtaining this paper is by specifications, and they should be made with both the producer and the consumer sitting around the table. The five requisites for a good specification were brought out, namely: (1) accuracy and precision, (2) workability, (3) suitability, (4) flexibility, and (5) acceptability.

Samples of permanent forms used in the insurance business were shown made from 100% rag bond, 100% rag ledger, and 100% rag index.

The Metropolitan Life Insurance Co.'s specification for 100% rag bond was then read and discussed, showing the reasons for different requirements.

Lewis S. Reid, Metropolitan Life Insurance Co., New York, N. Y.

Business Papers

Harry O. George

It seems a little presumptuous for me to appear before you, who supervise the manufacture of paper and the control of its quality during manufacture, to talk about paper. I can only hope that our special requirements and problems are sufficiently unique and interesting to justify time on your program.

When I was invited by Miss Kiely to speak at this meeting, it was suggested that you might be interested in how we go about developing the specifications which we provide to our paper suppliers, and how we test the paper which is made for us. It was further suggested that we may have some type of paper which because of its novel requirements might be of particular interest.

Paper is very vital to the operation of the machines which IBM manufactures. In the first place the very operation of our machines is controlled by paper in the form of punched cards or punched tapes. In the second place the final product of our machines is a report which is prepared on paper.

Harry O. George, Paper Technologist, International Business Machines Corp., Endicott, N. Y.

Not only is paper very important to us but we are also of the impression that the paper consumed by our machines is of some significance to the paper industry. I have brought with me a few samples of paper products used in our machines, to better acquaint you with the type of materials on which this discussion will be based. These are the punched cards which through accurately positioned holes actuate counters and the printing mechanism of our electric accounting machines. These perforated paper tapes control the operation of our carriages instructing the machine how to space the forms on which the reports are to be printed. These reports may be printed on rolls of bond paper, or if multiple copies are required, on continuous forms made up of several layers of bond paper interleaved with carbon paper. Sometimes these continuous forms must be made up of a special porous paper which is backed up by a special carbon. These forms become masters from which permanent ledgers are posted by means of the facsimile posting machine. The process of posting is a form of spirit duplication except that each line is duplicated on a separate ledger.

Another paper product of interest is the test scoring machine answer sheets. These are widely used by schools, civil service, and by the armed services to do away with the tedious job of manually correcting examination papers. In these answer sheets, electrically conductive pencil marks govern the magnitude of the reading on an ammeter.

Most of the products I have shown you are functional papers which must meet exacting specifications. Our method of developing a specification is probably typical of the method used in developing all specifications. It can be broken down into four steps.

1. When confronted with the problem of providing paper for a newly developed machine we have to draw on related experiences to prepare very rudimentary specifications. We then obtain samples of paper which have the properties we think the new application will require.
2. The next step is to try the various samples of paper in the new machine in order to determine which gives the most satisfactory operation. Tests of this sort must be made under various atmospheric conditions because our machines must function at all seasons and in all climates.
3. When we have found the paper which gives most satisfactory performance, detailed specifications are based upon laboratory tests of that paper. Wherever possible we use standard testing procedures such as those established by TAPPI. Sometimes when no standard testing procedure is available we find it necessary to develop our own instruments and techniques. In the writing of specifications the establishment of tolerances acceptable both to the paper manufacturer and to the machine which is to use the paper may prove to be the most difficult task of all. Anything which you papermakers can do to improve the uniformity of your product will lessen the problems which confront the users of your paper. We may have determined that a paper 0.0065 in. thick gives excellent results in one of our machines. If the next lot of paper produced for us is only 0.006 in. thick the results may be entirely different. It therefore becomes necessary for us to establish both a maximum and minimum tolerance which requires a great deal of testing on our part. While we recognize the necessity of tolerances to the paper manufacturer we must often strive for narrow tolerances in order to obtain good machine performance.
4. Once detailed specifications have been established that does not mean that they won't be changed. We may find as the product is used in greater quantity under widely varying conditions that we have overlooked something. That means a revision of the specification. Sometimes we find that a factor once thought important is of little significance. Such a finding results in a simplification of the specification.

Occasionally a specification, even though desirable, has to be modified because of the inability of paper mills to meet the requirements. Fortunately changes of this type need rarely be made because we have generally found paper mills able to meet our essential requirements by increased research activity and improved technological advances.

We believe it may be of interest to examine both the usual and the unusual tests and point out why they are of importance to a product such as punched cards.

Close control of basis weight is always desirable. In some cases a paper will not function properly unless it has the correct weight. Some of our electric accounting machines have stackers in which the level is maintained by carefully adjusted springs. If the punched cards are too light in weight they will not depress the stacker springs sufficiently. The same problem exists on the presses which print the cards. Uniformity of basis weight is also an important factor because we buy paper by the pound and sell it in units of a definite area. The larger the amount of paper purchased the more important this factor becomes. It takes only a small increase in average basis weight to add substantially to our yearly paper bill.

Thickness is important in many of our papers because of the close relationship between thickness and stiffness. Our punched cards are fed from the bottom of a stack through an opening large enough to admit only one card at a time. If the cards are so thin that two try to enter at once a card jam results. If cards are too thick even a single card may be nicked in passing through a closely adjusted opening.

Thickness also has to be carefully controlled in order to be able to pack the correct number of units into a box of a specified size. Since we pack 2000 punch cards into a unit container, a variation of 0.0005 in. from normal thickness will make a difference of 1 in. in the space these cards will occupy.

Strength and durability of paper as measured by bursting strength, folding endurance, tearing resistance, and tensile strength are important properties in functional papers which have to withstand a great deal of manual handling as well as repeated operations in machines. In the case of the perforated tapes which control the operation of the carriage we have tried many materials including paper, plastics, and combinations of the two. So far we have found nothing superior to a high grade of 100% rag bond. The tape is kept in proper registration by pins which engage perforations in the tape. When tapes do wear out it is from elongation of the perforations. The durability of paper as compared to some other materials in an application of this sort is remarkable, but still greater durability without increase in thickness would be desirable.

Moisture content is an important property in many of the papers we use. If the paper is too wet or too dry it may show excessive curl either at low or at high humidities. Variations in moisture content may affect registration. The paper tapes which we have just discussed are printed in one operation and perforated in another. A change in moisture content between these two operations will result in poor registration of the holes with the printing. In the case of punch cards, high moisture content in paper at the time the cards are cut to length or the paper slit to the proper width, will result in excessive shrinkage by the time our customer is ready to use the cards. This could be serious for the successful operation of our equipment depends on accurate location of the holes in the cards as they progress through the machines. For the paper which goes into the punch cards we specify a moisture content of 5.5% with a tolerance of $\pm 1\%$. We would like a narrower tolerance but experience with several mills has shown that closer tolerances are not practicable as yet. Some day we hope they will be. Some of you may think these tolerances are broad and easily met but few mills realize the moisture content variations in their product. It is common practice to take fairly large samples, sometimes a strip across the entire machine. When you do this you are striking an average. To us it is important that any strip $3^1/_4$ in. wide across the entire machine be within the specified tolerances.

Moisture content is of such importance that we determine it for every roll of paper which goes into our punch cards. This means a lot of testing so we need a quick yet accurate method. We have found the Emerson speed drier a useful tool but to improve the accuracy of our results we substituted an aluminum plate for the steel plate with which these driers came equipped. We also rearranged the heating units for greater uniformity and drilled holes in the edge of the

plate so that we could insert Weston dial thermometers. In establishing our procedures we adjusted time of drying and temperature until our results checked closely with the TAPPI method which is too slow to be practical when results must be obtained quickly.

More recently we have found that we can make a rough preliminary check of moisture content by measuring electrical conductivity through the entire roll of paper. This method does not tell us the exact moisture content but it does tell us whether or not we are well within safe limits. In the case of questionable rolls we still have to weigh paper samples, dry them, and determine the per cent of moisture which is evaporated. The electrical method, however, provides adequate testing for at least 95% of the rolls of paper which we convert.

Close control of coefficient of friction has proved to be important in the manufacture of paper for punch cards. If the coefficient of friction is too low the cards may slip out the operator's hands. This can be very disconcerting when the customer has carefully sorted the cards into the proper sequence and because of slippery paper drops the cards and has to do the sorting job all over. High coefficient of friction results in excessive stresses on the edges of the cards for we feed single cards from under a deck of 600 or 700 cards. Excessive variations in coefficient of friction may also affect registration of the cards in the machines.

Since we knew of no commercial device for measuring the coefficient of friction of paper we had to develop one. The device which we built for this purpose has a sensitive horizontal spring scale which is advanced at a constant rate of of speed. This spring scale acts against a 100-gram weight resting on the top card and determines the force in grams required to slide the upper card over those on which it is resting. In testing the coefficient of friction it is necessary that the cards be properly conditioned with a minimum amount of handling for coefficient of friction is an elusive property. To have any significance the test must always be conducted in exactly the same manner.

Curl is objectionable in nearly all papers but there are few in which it is as objectionable as in the paper used for punch cards. Excessive curl makes it difficult to feed the cards mechanically. To insure a reasonable degree of flatness we measure curl in cards at relative humidities of 20 and 75%. Cards for this test are stacked both wire side up and felt side up. We recognize three types of curl: valley with the grain, valley across the grain, and diagonal curl. All are objectionable but not to the same degree. In measuring curl we allow adequate time for conditioning of the paper so as not to confuse temporary curl caused by uneven distribution of moisture with inherent curl due to lack of uniformity in fiber alignment, variations in finish or surface sizing.

Paper used in punch cards and in test scoring machines answer sheets must have good dimensional stability. Dimensional stability in these papers is important because the results depend on accurate location of the punched holes or of pencil marks. Excessive shrinkage at low humidities may result in misregistration while excessive expansion at high humidities may cause the cards to bind in the machines. We find that the most practical means for us to measure hygroexpansivity is to condition cards in humidity controlled rooms and measure them with specially constructed dial gages. Our results obtained in this manner are accurate and we can test any number of samples at once. This system does not, however, lend itself to measuring hygroexpansivity of lightweight papers and does require several humidity controlled rooms.

Punched cards must be free of conductive particles which if present would register as punched holes. They must also be free of materials which might interfere with the electrical contacts which wire brushes must take through the holes onto contact rolls. To insure the absence of conductive particles the entire surface of the paper web is sensed electrically as the paper feeds on our printing presses. A means of ejecting cards which contain conductive particles or holes is provided.

To determine the effect of paper on electrical contacts in the machines it is necessary to feed thousands of cards through machines under simulated field conditions. Standards of performance are established and any early electrical failure of the machine is given close scrutiny. Early electrical failures may be caused by dust from the paper or even by sulphur or sulphides in the paper which cause tarnishing of the contact roll. These are conditions which cannot be tolerated and must be guarded against by extensive testing of card stocks on our various machines.

Abrasiveness of paper can be a very great expense in the servicing of our machines for it is necessary to maintain punches in condition to produce clean holes. We know of no short cut to determining abrasiveness of paper, so our test consists of punching millions of holes in a web of paper under test and observing the cleanness of punching. The lack of abrasiveness is determined by the number of holes which can be punched before the holes become too fuzzy and ragged for proper functioning in our machines. If there is a simple short-cut to this time and paper-consuming operation we would like to know about it.

Static in punch cards is an undesirable condition. It can make cards difficult to handle and can interfere with proper stacking. The amount of static which is experienced is closely related to the electrical conductivity of the paper. We use the paper as an electrical insulator but to avoid static problems it must not be too good an insulator.

Some control of static has been obtained by control of the electrical conductivity of the paper.

In some applications punched cards are kept in files for many years. For this reason we must control aging quality by specifications pertaining to pH and to folding endurance after accelerated aging. These, however, are tests familiar to all of you and need no further discussion.

This discussion has been somewhat sketchy, but I hope I have been able to give you some idea of why careful control of paper quality is important to a paper consumer such as the IBM. It is gratifying to have been able to observe definite progress in the control of paper quality over a period of years. We have every reason to believe that this progress can continue through the cooperative effort of those who make paper, those who supply chemicals to the paper industry, and those who consume the paper.

Electrical Papers

P. L. Staats

The use of paper and paper products as electrical insulating material is one of the most satisfactory solutions to the difficult problem of insulating electrical apparatus. From an economic standpoint, the paper machine is a very efficient means for forming sheet materials of good quality suitable for electrical barriers at relatively low cost. The widespread use of paper in a multiplicity of industrial and consumer uses confirms this fact. For the electrical industry your mills produce paper products as thin as 0.0002 and as thick as 0.250 in.

Let us attempt to classify these electrical papers in order that we may have an idea of the types of papers used. Table I lists electrical papers according to usage. While this classification may not be complete we can differentiate at least six kinds of paper materials which are used by the electrical industry.

At the present stage of development not more than three general types of basic fibers are commonly processed for use in insulating papers: coniferous wood pulp, cotton rags, and

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Table I. Classification of Electrical Papers by Usage

Material	*Key properties*
Coil papers	High dielectric strength, tensile, tear, thickness
Slot papers	High dielectric strength, tensile, tear
Saturating papers	Uniformity, uniform shrinkage, thickness, porosity
Condenser paper	Thickness, dielectric strength, very high stability, low loss characteristics, uniformity
Pressboards	Thickness, stability
Vulcanized fiber	Dielectric strength, rigidity, density

manila rags. The conversion of these materials into electrical insulation is the function of the paper mill.

It is the function of the consumer to specify the properties desired and required in the papers used as insulation. These requirements will determine even the type of machine used in the manufacture of the paper insofar as its properties are affected.

Table II shows the papers listed in the first tabulation, but here classified according to the type of paper machine used in their manufacture.

Table II. Selection of Electrical Papers by Method of Manufacture

Fourdrinier machine paper	*Key properties*	*Cylinder machine paper*	*Key properties*
Condenser paper	Uniformity, thin, thickness	Slot paper	Tear, tensile
		Cable paper	Tear, tensile
Saturating paper	Uniformity, shrinkage, porosity	Pressboards	High thickness, dielectric strength
		Coil paper	Tear, tensile, dielectric strength

EFFECT OF MILL CONDITIONS

Of prime importance in the manufacture of electrical papers is the removal of solid contaminates from the pulp suspension. The usual techniques as applied in the beater have been extended through the use of Centrifiners, Vortraps, and Dirtecs. Dirt to the electrical consumer may mean conducting particles.

The residuals which the mill processes leave in the paper are extremely important. In this latter connection, we should especially consider acidity and alkalinity, electrolyte additives, i.e., sizings and filters, and ash.

It is well understood that acid conditions in the paper have a serious degrading effect on the life of the insulating material. The measurement of the pH of the water extract of paper is an excellent means of determining the degree of washing applied by the mill to the paper and to some extent it is an indication of the presence of sizings which are often accompanied by an acid condition. For example, a paper sized with rosin may have a pH of 4.5 while unsized 6.0 to 7.0 is expected. It is known that a size contributes to the dimensional stability, however, for certain electrical uses, even a small amount may be objectionable.

The presence of electrolytes in electrical papers is a problem which often causes considerable confusion to the paper manufacturer. The source of such contamination may be extremely fugitive. A consumer who produces liquid-filled electrical apparatus is particularly concerned with the possible presence of electrolytes due to their effect on the electrical characteristics and life of the insulating liquids. In general, the electrical industry desires that its paper be nothing but paper.

The ash value of the paper is a very definite indication of the purity of the material: for critical uses a maximum limit in the order of 0.5% has been generally established.

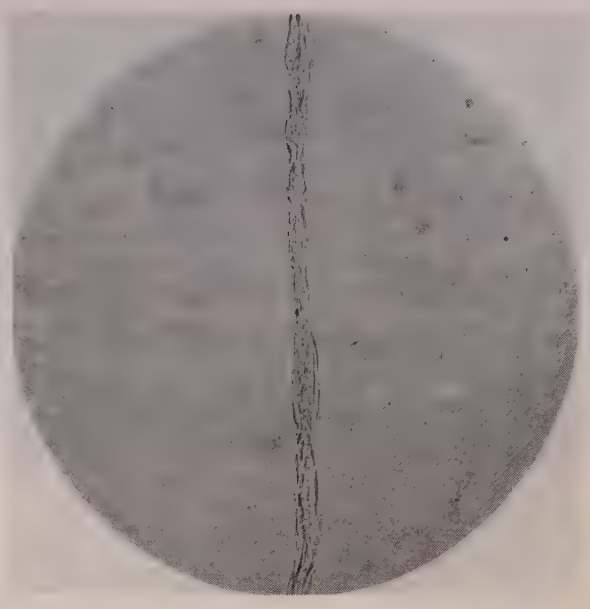

Fig. 1. Cross section of 0.0005 in capacitor paper

DIELECTRIC STRENGTH AND POWER FACTOR

To consider completely problems connected with the use of paper in electrical apparatus, we must discuss dielectric strength and power factor. Almost any characteristic of paper has at least some influence on these two properties, including the raw material, manufacturing process, and the paper structure.

Most papers intended for electrical use are expected to contribute their proportionate share of the total insulation of a particular apparatus, hence, dielectric strength is an extremely important property. The values obtained are subject to many influences including the physical properties of the sheet and the certain mill conditions.

It is well established that dielectric strength is a function of uniformity and density. The papermaking process influences the fiber structure; in a similar manner, it can affect the uniformity of the paper. This is well illustrated* in microphotographs of cross section of papers, Fig. 1. The specific gravity of the sheet has a more obvious effect, the higher the gravity, the higher the dielectric strength. Electrical papers, therefore, require definite specific gravity in order to maintain the proper level of dielectric strength

The degree to which the paper mill removes solid contaminating materials such as pieces of iron, copper, or carbon has a very definite effect on the usefulness of a paper as insulation. The paper and electrical industry have gone to great expense to reduce these conducting particles to an absolute minimum. During the last decade, the particle counts per square foot on capacitor paper have decreased from over 20 to 1 or less.

With all due respect to these improvements further decrease in conducting particles is necessary and is vitally important from an economic standpoint. Many insulating papers are as a routine measure given over-all electrical inspection to preclude areas of low dielectric strength from use. When this process is not feasible, additional layers of dielectric paper are used to prevent failure. Therefore, manufacturing and material expense go hand in hand with the conducting particle count.

Much work has been done, the paper industry has im-

*Cross section by method developed by Transformer & Allied Products Laboratory, General Electric Co. Publication by N Galitzine and K. P Kries, Pending.

The DRAPER Felt
DRAPER BROTHERS COMPANY
CANTON, MASS.

proved the methods of dirt removal, conducting materials have been identified, and correlations established with the number present and the failures found in electrical apparatus.

For both the paper manufacturer and the consumer the problem remains one of extreme importance. No completely satisfactory means for the continuous testing of paper during the manufacture has been developed. Such a method would aid to a great extent in relating the occurrence of particles to mill conditions. Only when this is done, can we expect further improvement in particle removal.

One of the most important properties of any paper produced for an electrical use is its power factor. Like dielectric strength, power-factor value of a material is influenced by several factors both chemical and physical.

The base pulp used has a very definite effect, rag fibers, wood pulp prepared by the various cooking processes all produce papers with different electrical properties. The degree of purity of the specified pulp itself has an influence on the power-factor characteristics. For pulp made from northern spruce, which is one of the most suitable fibers found to date for electrical papers, a very definite degree of chemical purification or removal of noncellulosic constituents can be shown to be important for the most satisfactory loss characteristics of an electrical insulating paper.†

Manufacturing experience has shown that water conditions existing at the time a paper is manufactured have a definite influence on the power factor of the paper. Such results are undoubtedly due to the electrolytes contained in the process water. It is a well-known fact that a general correlation exists between the resistivity of water extract of paper and its power factor, likewise specific cases can be cited of power-factor difficulties traced to a mill which had available two sources of process water, one of high resistivity and the other suitable only for paper on nonelectrical purposes. In each case, it has been found that low resistivity water was used in the papers which exhibited high power factors. Too much stress cannot be placed on the necessity of pure water.

CONCLUSIONS

Electrical papers are a class unto themselves among the industrial papers.

The problems and requirements are those which are dictated by usage, which in turn determines the raw materials, the manufacturing process, and the quality of the finished products. Due to the specialization required a distinct class of paper products has been developed for the requirements of the electrical industry.

The physical, chemical, and electrical properties of paper made for electrical apparatus must be closely controlled; the development of new paper insulating materials must necessarily start with the pulp and concern itself with the processing of the stock through all stages of the making process in order to produce a sheet suitable for the purpose desired.

† Miller, H. F., and Hopkins, R. J., A new kraft capacitor paper. *G. E. Review* 50: 20–24 (1947).

The Technical Program at the University of Maine

John B. Calkin

The growth of technical people in our pulp and paper industry, and the relations with superintendents and management can be readily seen by reviewing a few incidents from a few years before the turn of the century up to the present.

About 1890 a young chemist called on P. H. Glatfelter, Sr., then President of P. H. Glatfelter Co. in Spring Grove, Pa. Mr. Glatfelter told the young chemist that he did not think they were educated to the point of hiring a chemist, and added that he was the first one he had met. However, Mr. Glatfelter told him that he could go wherever he wished to go in the mill, ask questions, and stay as long as he wanted to. The young man retired as Chief Chemist in 1929. Those were the days when a chemist had to sell the job first.

Harry Carruth has said that along about 1914 he and Hervey Skinner had a day train trip from Washington to Boston and discussed forming a group of technical men in the pulp and paper industry. Between them they set down some twenty whom they knew. This was the start of TAPPI.

In 1918 a young lady from Smith College entered the industry with American Writing Paper Co. Another milestone was reached when the industry found that there was a place for women chemists.

By 1927 some companies had pretty well-organized research departments, and I entered the employ of Brown Co. as a microscopist. Since many people found this a hard name to pronounce, I made it easier for everyone by becoming a chemical engineer, one of those "glorified plumbers."

These incidents illustrate the growth of the technical man in the industry. Before the turn of the century even a forward looking executive may not have met a chemist, but when he did he was quick to sense a possible addition to his staff. By the time of World War I, two well-known men in the industry could think up a couple dozen technical men to form a group. By the early twenties women chemists were entering the industry, and by the late twenties fairly large research organizations were under way.

Trained engineers are vital to modern paper manufacture, because automatic devices and high-speed machines require engineering "know-how" to install and maintain. Today we find that a technical graduate has several offers and must make a choice.

The past 25 years have brought papermaking nearer to a mechanical science, and while many present-day superintendents base sound judgments on long practical experience, the trend is increasingly toward trained men.

John B. Calkin, University of Maine, Orono, Me.

In addition, most of the younger generation now coming through the mills have a background of preparatory work. As times change papermaking has become more precise, and increasingly, paper must be made to certain specifications. Then, too, the increasing number of end uses for paper demand specialized treatments which require a chemical background, treatments such as beater additives, resins, melamines, urea, various types of starch, and many others, as well as new coating processes and printing techniques.

Development of more efficient methods of paper manufacture, reduction of process wastes, and utilization of waste products, have been accomplished in large measure by engineers with chemical, electrical, and mechanical training.

Turning to the superintendents and the technical people, may I relate a conversation that occurred in the middle twenties while I was working at the Glatfelter paper mill in Spring Grove, Pa.

I was in the beater room one day talking to the late Dan Baker, the super. We were just watching the stock in the beater, and talking about not much of anything. Dan was a big guy (he had his overalls made to order because they just did not come his size), a prince of a fellow with a heart of gold. Finally, he said, "I can tell you more about this stock in two minutes than you can with all the tests." By jove, he could, so I agreed with him, and said, "How do you do it?" "Well," Dan said, "you take a handful of stock and you squeeze it, you pull it apart, you look at it, you chew it, and then you know the right time to dump the beater." Dan had a lot on the ball, and a real canny fellow like that could tell a lot about stock that way after a number of years. Then, we got to talking about how you couldn't put down test results that way. We got to the nub of the thing when we agreed that as the supers and papermakers and the technical people pooled their knowledge–sometimes it was their ignorance—and cooperated, that the art of papermaking has advanced. That sort of cooperation has been going on in our industry for years.

In those earlier days some of the kids were pretty cocky, and I remember one summer I was working on the power crew. We had some high water, and it left about an inch of mud on the powerhouse floor. The chief engineer left word with the master electrician, that I was to clean it up. I figured that I'd served my time on the yard gang, so I went at it half-heartedly, and vowed that I would have it out with the boss, but before I did something happened. That afternoon we were getting the cab on the monorail bale lift in place, and we were shorthanded—the chief engineer helped us. Then I got to thinking that he wasn't hired for that kind of job. You can guess what happened the next morning.

I am sure that a lot of technical people, and superintendents too, have pitched in, and helped to clean up a mill after high water. Ice breakers like that have brought the supers and tech people into closer cooperation. There are fewer laboratory recluses because we have all found that we are intensely human. Maybe some of us are a bit harder to get to know than others, but as we work toward the same goal some of these things fade out of the picture.

In this mutual understanding the University of Maine has played its part. Back in 1912, Professor Ralph H. McKee started the first courses in pulp and paper technology in America, and thus made Maine "the cradle of technical education in the industry." Through the years Maine men came into the pulp and paper and allied industries as mechanical engineers, physicists, chemists, chemical engineers, electrical engineers, foresters, economists, and other specialized fields. Today there are over 600 Maine alumni in the pulp and paper and allied industries.

In the Summer of 1949 the University was approaching another milestone. Phil Bolton, another chairman of New England TAPPI, and a Maine alumnus, laid before a group of alumni and University staff an idea he had been hatching for a while. That was a 5-year course in operational management to train men for production jobs in the pulp and paper industry. This is not, of course, aimed at producing executives in the allotted 5 years, but simply to give young men, with promise of being managerial material, a broader background. These boys, upon completion of the course, start at the bottom of the ladder, although it is of course expected that with a faster start the company will not have to spend as much time and/or money in the training of its managerial personnel.

This idea of Phil Bolton's took hold then and there, and has been growing since.

Fred Soderberg, whom many of you know, conceived the idea of The University of Maine Pulp and Paper Foundation to implement the idea by awarding scholarships for the fourth and fifth year. By July, 1952, eight men will have completed this course, and there are more on the way.

May we just take a look at what these students study for this specialized, yet broad training. The first three years are the usual first three in an engineering education, but after that they get a real dose. They continue in courses in the specialized branch of engineering, and in addition pursue work in pulp and paper technology, and extra dose of economics and psychology is given to them, they add on some accounting, labor problems, and corporation finance and some other subjects.

Two summers of work between the third and fourth, and the fourth and fifth years are required. They won't come out full-blown production men, but they will have some background and a few rough edges have been trimmed off.

This program of The University of Maine Pulp and Paper Foundation has had the wholehearted endorsement of industry. A total of 41 companies and 125 individuals have invested in The Foundation. This includes practically every mill in Maine, as well as a number of others outside of Maine. As you can readily see The Foundation, as a partnership between industry and education, has good backing in its long-range goal to supply the industry with well-trained men.

This objective of greater service is to be obtained through:

1. Scholarship grants which are available to carefully screened students. Men selected will usually have chemical, mechanical, or electrical engineering backgrounds, which will ultimately qualify them to supervise one or more operating groups.
2. Funds are available for loans to students to be paid back after graduation.

No college or university has a more impressive record than Maine in the preparation of men for the paper industry.

An excellent teaching staff has been augmented recently by the appointment of C. M. Howell as Lecturer in Pulp and Paper Technology. Mr. Howell, who holds a Master of Science degree, formerly was an instructor at Swarthmore College. During his business career with Scott Paper Co. he became General Manager and a member of the Board of Directors. The University of Maine is fortunate in having a man of the type of Mr. Howell who, in addition to an engineering background, has been associated for such a long period with practical papermaking operations. This combination of the theoretical and practical aspects of paper manufacture, places Maine in a unique position in the field of education for the pulp and paper industry. The competent instruction of capable students will help to reduce industry's on-the-job training problems.

Industrial research, both fundamental and applied, at the University is concerned with investigating such problems as stream improvement, utilization of bark, measurements of values of beater additives and many other areas, all of vital interest to every pulp and paper company.

The University of Maine has been referred to as "the cradle of technical training in the pulp and paper industry" and will soon celebrate the 40th anniversary of this forward step. Another milestone in this program came with the formation of The University of Maine Pulp and Paper Foundation only a little more than 2 years ago. The modest steps referred to

above have been the outgrowth of this heightened interest in pulp and paper technology at the University of Maine. The program offers you, as well as the many companies who have already joined, an opportunity to participate actively in the development of more competent supervisory personnel.

There are two forms of company membership: (1) company scholarship underwriters, $2500 per year, minimum; (2) company membership, $1000 per year, minimum.

All members are kept in constant touch with the work of The Foundation by means of reports and visits by members of the faculty. Suitable recognition of membership is inscribed on permanent bronze scrolls prominently placed at the University.

The high professional standing of the engineering departments at the University of Maine has contributed to the usefulness of this school not only to the pulp and paper and allied industries, but to industry in general. In the almost 40 years that Maine has been preparing men to enter the pulp and paper and allied industries, she now has an alumni body of over 600 in these fields.

In closing may I add a little personal note to say that I have been in industry previous to returning to the University of Maine in 1949, and it is most heartening to see the lift that the whole program here has received from the support of the pulp and paper and allied industries through The Foundation.

LETTERS TO THE EDITOR

Bleaching Bibliography

To the Editor, *Tappi:*

I was interested in the report of the Pulp Purification Committee in the June issue of *Tappi* and the comments on a bibliography on bleaching.

For some time the Institute has had in preparation a bibliography on this subject; at present I believe that the compilation is about 95% complete. It is hoped that the work may be completed this year and that it may be distributed in 1953.

There has been some question as to the best method of presenting the material. One might suggest that a classification of the references by the type of pulp bleached or by the bleaching agent might be used. The trouble is that, today, almost any type of pulp can be bleached by almost any agent or combination of agents.

An alternative would be to arrange the references in strictly alphabetical order and then prepare a comprehensive index.

Another alternative would be to try to decide the major interest covered by a given article or patent, classify the articles according to these interests, and still have an index.

I would appreciate any comments you may care to offer about this question of classification of abstracts. *Comment would also be welcomed from any member of TAPPI interested in this field.*

C. J. West, *Editor*
Institute of Paper Chemistry
Appleton, Wis.

A Bouquet

To the Editor, *Tappi:*

May I express my sincere thanks for the services that the Technical Association is giving, especially the excellent magazine *Tappi.* There are none better and I see a large number of industry magazines.

Kristian Fougner
Vice-President in Charge of Operations
A/S Borregaard, Sarpsburg, Norway

Drying Rates

To the Editor, *Tappi:*

With reference to the TAPPI Data Sheets I wish to inquire about a particular which I do not understand. All the curves start from a steam pressure of zero or even below zero. Some plotted points are also in the vicinity of steam pressures of zero. Would you be kind enough to explain this phenomenon?

Fr. Pfulg, *Engineer*
Paper Industry Technical Bureau
Cologny-Geneve, Switzerland

To the Editor, *Tappi:*

I suggest you reply to Mr. Pfulg explaining that we do have in this country on certain grades of paper a fair number of machines operating with an average steam pressure in the driers on zero p.s.i. or even lower.

In most cases I believe it will be found that the pressure is graduated with the wet-end driers at perhaps 2 or 3 lb. steam pressure. After all, if there is sufficient drying surface there is no reason why paper cannot be well dried with zero p.s.i. in the driers.

I believe it is understood by Mr. Pfulg that the curves were drawn to correspond with the data and not from any preconceived idea of how they should run except in the cases where the data are inadequate to determine the slope of the curves, in which case they are drawn to correspond with the slope which had been found in the cases of other grades of paper where there were adequate data.

A. E. Montgomery, *Vice-President*
J. O. Ross Engineering Corp.
201 N. Wells St., Chicago 6, Ill.

"After twenty years of research, Quimsey developed the answer . . . now he's forgotten the question!"

Electrical Merchandising via ETL Topics

REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Fibrous Agricultural Residues Conference

The round-table on "Straw Pulping and Processing" convened in Parlor B of the Commodore Hotel, New York N. Y., at 9:30 a.m., Thursday morning, Feb. 21, 1952, S. I. Aronovsky, Northern Regional Laboratory, Peoria, Ill., presiding.

CHAIRMAN ARONOVSKY: You will recall that at the last meeting of this group in Peoria, in 1950, we had decided to to have a round-table discussion of problems relating to the strawboard industry and its various phases: straw procurement and operation, pulping, pulp treatment, and paper and board manufacture. Mr. Knack, Chairman of our Subcommittee on Board and Paper Manufacture, volunteered to get up this round-table, and sent a request for topics around to the various mills. After a certain amount of correspondence, Mr. Knack received quite a few topics, and we are going to discuss them today. I do not know whether we will get through all of them or not, but we'll go as far as we can.

I wish that at the end of this meeting, the members of the committee (everybody is invited) would stay for some announcements regarding our next meeting.

I will now turn the meeting over to Mal Knack, moderator of this discussion.

M. F. KNACK (General Superintendent, River Raisin Paper Co., Monroe, Mich.): Will you please give your name before you ask a question or make any remarks, so that it can be put in the record. The record of this discussion will be published, so that you will have some way of knowing what did go on. You will be given a chance to review any remarks that you make, the transcript will be forwarded to you; you may delete any remarks that you think probably don't sound exactly as you intended them to, or you can delete your remarks entirely, so don't hesitate to speak up just because your remarks are being recorded.

The questions that were submitted by members of the committee and others who are interested in the problems of this industry covered a wide range of subject material, starting out with raw materials, through cooking, stock preparation, papermaking, quality, and theory. I think perhaps we might just as well go through them in the order in which I gave them.

The first question: "Do agricultural residues, namely cereal grain straw and soybean straw, offer as much or more possibility for a raw material, quality-wise, as the native hardwoods?"

Now does anybody have anything he'd like to contribute to that question? I think what's in everyone's mind is the competition of hardwood corrugating medium, chem-fiber, or whatever you care to call it.

E. C. LATHROP (Northern Regional Research Laboratory): Is that a question of quality or a question of economics?

MODERATOR KNACK: Quality.

MR. LATHROP: Well, my own opinion is that the quality that is required for corrugating mediums—and I'm referring mainly to stiffness—is probably due to the pentosan content of the pulp which, in turn, goes back to the raw material, and I believe that until it was discovered how to pulp the hardwoods to get high yield which, in turn, meant preserving their hemicellulose content—that not a very stiff sheet was made. Now then, if we go back to fundamentals, we find that these residues, with the possible exception of soybean stalks, are higher in hemicellulose than most of the hardwoods.

I think another angle that you have to consider in this picture is the fact that a great deal of research work has been done on the production of semichemical hardwood pulps. My own feeling is that, in any old industry, you have a certain amount of tradition to overcome, which interferes with the application of new research results. Semichemical pulping does not have old tradition with which to contend.

I don't know, however, that we definitely know the answer to this first question, yet.

CHAIRMAN ARONOVSKY: I might say this with regard to soybean stalks: I don't believe, on the basis of the small amount of work that we have done experimentally with soybean stalks that they are or can be made into as good a product as either the hardwoods or the cereal grain straws from the standpoint of the fiber characteristics. The soybean stalk is composed of a very thin sheath of long fibers; it is probably the bark of the stalk. The inside is mainly woody tissue with a fair amount of pith as a central core.

That woody tissue is fibrous, but the fibers are very, very short—much shorter than any of the hardwood fibers that I know of, and they fall in about the same category as flax shives, hemp hurds, and materials of that type.

F. B. GRUNWALD (Consolidated Paper Co., Monroe, Mich.): I don't know too much about what is in the soybean straw, which prevents it from running on the paper machine as successfully as straw, but we have made a better sheet from soybeans than any straw we have ever used; but it is too difficult to operate.

During the war, one winter, we used about 5000 tons of soybeans, because straw was scarce. It slowed the machine down about 50 ft., but was a very acceptable operating medium.

CHAIRMAN ARONOVSKY: Did you run it alone?

MR. GRUNWALD: No, it wouldn't run alone, except at very reduced speeds.

CHAIRMAN ARONOVSKY: Again our experimental work showed that we were able to get a pretty fair ring crush test with straw containing up to 20% soybean stalk pulp. Above that there was a definite reduction in strength characteristics which went down as you increased the amount of soybean stalks in the blend.

MODERATOR KNACK: Mr. Cassiday, do you have anything to contribute on the comparison of agricultural residues, cereal straws, or soybeans, to native hardwoods?

W. L. CASSIDAY (Alton Box Board Co., Alton, Ill.): Well, my feeling on the matter is that perhaps we still have a lot to learn about the best way in which to pulp these agricultural residues, wheat straw or soybean stalks, or whatever they may be, to find the optimum conditions there.

As it is now, under our present conditions, I think soybean stalks are quite inferior to wheat straw in crushing strength, but I think perhaps we just haven't found the right way to handle their preparation before cooking, proper cooking conditions, and proper refining after cooking.

CHAIRMAN ARONOVSKY: I might add that the soybean stalks require considerably more chemical and cooking to bring them down to the fiber stage. It is a woody stalk with a relatively high lignin content.

MODERATOR KNACK: In cooking soybeans, has anyone tried cooking them entirely separate from the rest of their straw furnish using different chemical combinations than they do for the regular straw?

MEMBER: We used to cook them separately; we could

never mix them. We mixed them later on in refining. We never did 100% soybeans. You cannot cook soybeans and wheat straw with the same cooking formula; if it's good for the wheat, your soybean is going to be raw.

MODERATOR KNACK: Did you use more chemical?

MEMBER: Oh, definitely. I would say roughly twice. Your cooking costs twice as much as on wheat straw.

J. R. LITTLE: (The Hinde & Dauch Paper Co., Sandusky, Ohio): I think it can be cooked satisfactorily in small percentages with wheat straw. In other words, you can put 5 to 10% of soybeans in with the wheat straw. It should be put in first before the straw. Cooked with caustic, the soybean apparently takes the chemical before the straw does.

MODERATOR KNACK: Actually, we cooked the two in combination, also. I wouldn't guarantee that we got the best possible results out of either the straw or soybeans, but we put our soybeans in with the first fill along with a portion of our chemical—at that time it was lime—and then added the balance of our straw on the second fill. We got some sort of a pulp out of it.

MR. GRUNWALD: May I ask John a question: Did you put in the 5% to get a better sheet, or due to lack of straw?

MR. LITTLE: Lack of straw. With us, it isn't as economical to use soybeans as it is to use straw. If you get very much in there, it will slow the stock down so you can't run as fast; but we can run up to 10% soybeans without any trouble.

MODERATOR KNACK: Last year, when straw was a little scarce, there was a tremendous interest in soybean as a raw material. At the committee meeting we had the other afternoon, there was a complete lack of interest in soybeans; so I don't think anyone uses them by choice.

Let's move along because we have a long list of subjects to discuss.

The next subject we were asked to explore was: "Developments in improving wastepaper stock quality and pulping methods."

Now I assume that the person who asked this question is concerned mainly with methods of processing wastepaper stock rather than attempting to control the quality at the source. Those of us who are consumers of considerable quantities of wastepapter have long since decided that we'd best provide methods of improving the quality after we get it, rather than to try to improve it at the source.

Would anyone like to describe what he considers an up-to-date, modern stock preparation system for preparing wastepaper?

MR. GRUNWALD: Are we talking about straw and saying let's put in 20% paper stock?

MODERATOR KNACK: I assume that what they're referring to is the preparation of stock to blend with straw pulp.

MR. LITTLE: I think the thing is to be able to get the junk out of your paper stock. Use the ragger and junker, also a settling trough and thickener. I think that works very well. It is desirable to get the dirt out of it as much as possible.

MODERATOR KNACK: I think that is probably true. Dirt removal is very important from the standpoint of preserving your tackle and preventing trouble on the paper machine itself.

Most everyone, I believe, is familiar with the devices that are now available for removing dirt by centrifugal separation. There are the Vortrap and the Dirtec and the Hydrafuge. Those are the three principal devices that are used to separate dirt hydraulically. They do a very fine job.

The removal of the light portion of the dirt—material that does not come out by centrifugal separation hasn't been given quite as much attention; and while this dirt does not damage the beating tackle, it still damages the sheet. Probably that is the point where these cleaning systems are now weakest.

MR. GRUNWALD: Mr. Chairman, in talking about corrugating medium, we can't forget crush resistance. I find that as more paper stock is used, down goes your crush resistance, so the only reason I believe we have accepted paper stock in straw is to make it run better on the paper machine, not to improve the quality. When straw was scarce, wastepaper was a better substitute than soybeans, but to make board with a proper crush resistance, you don't want to use paper stock. That's my experience.

MR. C. LATHROP: That may have some relation to the hemicellulose content of the total furnish.

MR. GRUNWALD: I think we should learn to make good stock from straw and not in combination with paper stock.

CHAIRMAN ARONOVSKY: Fritz, when you say "wastepaper stock," what wastepaper stock are you talking about?

MR. GRUNWALD: I find the old corrugated boxes are certainly better than the old wastepaper.

MODERATOR KNACK: Well, we are here to talk about agricultural residue fibers, and I believe that it is pretty nearly an industry-wide practice to run a certain percentage of some sort of paper in the sheet, as you say, for the reason that you can get better running conditions on the machine and sometimes because wastepaper is cheaper than straw. That happens to be true at present, however, it is not always so. I am not entirely sure that you can't run a sheet of high-flat crush qualities out of some sort of paper stock, so you might get yourself into an argument on that point.

I think probably we shouldn't spend too much time talking about wastepaper stock qualities. Another question was asked: "How can asphalt difficulties in the wastepaper supply be overcome?" There is an answer to that question.

Earl Knapp, would you like to describe this asphalt dispersion system that was developed by The Institute of Paper Chemistry in conjunction with the jute research group?

EARL O. KNAPP (Weston Paper and Mfg. Co., Terre Haute, Ind.): The asphalt dispersing unit was developed by the jute research group in the paper industry, and The Institute of Paper Chemistry, and is used in conjunction with the Asplund defibrator. The stock is thickened in the neighborhood of 40% and run through the preheater to the point where the asphalt will melt, then through the defibrator to disperse it. It does a fine job of dispersing; it makes the sheet a little darker, but it apparently takes care of the asphalt and waxed paper, too.

MR. GRUNWALD: What's the temperature?

MR. KNAPP: I believe 30 or 40 lb. steam.

MR. GRUNWALD: That would be about 280°?

MR. KNAPP: Possibly.

MODERATOR KNACK: The steam pressure is 50 lbs.

MR. GRUNWALD: Which runs all over the map.

MR. KNAPP: Well, within limits, yes.

MODERATOR KNACK: Well, there may be other answers to that asphalt problem, but that's the one with which I happen to be familiar.

The fourth question on raw materials is: "Recent developments in competitive fibers, bagasse, wood, etc."

I think the bagasse might be considered a fibrous cellulose residue.

CHAIRMAN ARONOVSKY: That's right, it is.

MODERATOR KNACK: Would anyone have anything to contribute—any recent experience—on the pulping of bagasse for making any kind of pulp?

MR. GRUNWALD: Is that used for a corrugating medium?

MR. LATHROP: Yes, it can be used satisfactorily. It's a question of cooking it properly.

CHAIRMAN ARONOVKSY: Mal, you used the bagasse during the war, didn't you—several carloads?

MODERATOR KNACK: We made several experimental runs with bagasse. We got some that was fairly well preserved, some that was not so good. We were able to produce a sheet that ran fairly well on the machine. As I recall it, it wasn't distinguished by very high crush qualities. Perhaps we needed a little more experience in cooking it than we had. The yields were somewhat lower than what we get normally on straw. We never got into the use of bagasse on a very

large scale because the freight rate from Louisiana was quite stiff. That is as much as I have to contribute to the subject.

Has anyone else any experience on cooking bagasse?

MR. LATHROP: I think I might mention, on this, it is not just a question of cooking, it's also a question of refining; bagasse fiber is a harder fiber than straw so I think you must take into account your refining situation.

CHAIRMAN ARONOVSKY: Our experimental work shows that bagasse—that is the stored bagasse which has been partly attacked and decomposed by natural fermentation, and dried—gives almost as good pulp as wheat straw, from the standpoint of strength characteristics, such as bursting strength tensile, tear, and crush resistance. However, we have done some work at the Laboratory on depithing the bagasse, and when we cook the bagasse fiber from which most of the pith has been removed, using the same amounts of chemicals as we used for the whole bagasse fiber, we get a better yield and considerably better strength properties.

H. C. MARTIN (Brown Paper Mills Co., Monroe, La.): What portion of the weight of bagasse does that pith removed represent?

CHAIRMAN ARONOVSKY: I'd say the pith is around 25% of the total bagasse, but in removing the pith, a certain amount of dirt is also eliminated.

MR. LATHROP: I think your pith content actually is probably closer to 30%, but there is a certain amount that is lost because of its particle size, water solubility, dirt, and that sort of thing, which may represent 10% of the total.

MR. MARTIN: How does the pith left affect the pulp? Is it a stiffening effect, or not?

MR. LATHROP: I think it probably is, to a certain extent, on account of its great surface.

CHAIRMAN ARONOVSKY: In our work, a certain amount of fines has been deemed desirable to obtain crush resistance and good strength, but we have not yet determined the actual amount.

MR. CASSIDAY: Isn't it likely that the pith cells are very readily attacked by the cooking liquor and destroyed when the rest of the fibers are pulped?

CHAIRMAN ARONOVSKY: The pith will pulp much more readily. In line with experience with other raw materials, a material as fine as pith and with as large a surface, may have particles small enough to be actually dispersed in the liquor—not entirely dissolved.

MR. CASSIDAY: Would there be any way of determining microscopically whether there are any pith cells in the finished sheet?

CHAIRMAN ARONOVSKY: I think it would be a very difficult job, because you never get bagasse fiber entirely free from pith, and you would just have to make a good guess as to the relative amounts of pith material present.

MODERATOR KNACK: Does anybody have anything further to offer on bagasse?

Recent developments in wood were asked for in this question, too. Does anyone want to talk about what is being done in the way of semichemical fiber from wood?

I know that some of the mills are doing a considerable amount of work in cleaning up their pulp, removing bark and dirt from their sheet. Other than that, I don't know that the process has changed essentially

Does anyone have anything he'd like to contribute in that connection? If not, we'll move along to cooking.

We have already discussed the cooking of soybean at some length. Everyone seems agreed that if they can avoid it, that's the way they cook soybeans.

The other raw material that was brought up for discussion is oats straw. I think it is pretty generally agreed that oats straw doesn't produce the quality of pulp that can be obtained from wheat straw, but I think most of us, because our suppliers do collect this straw, use it to some extent.

Does anyone have anything to offer on the cooking of oats straw?

MR. GRUNWALD: I don't think you can make oats straw come out as good as wheat straw. As you said, I think it's a necessary evil.

MODERATOR KNACK: I think most everybody uses it as a part of his straw furnish, cooks it exactly the same and expects somewhat poor yields and not quite so good a sheet.

Does anyone take any exception to that?

MR. KNAPP: I wouldn't exactly take an exception to that, but we have done quite a bit of work on the cooking of oats straw separately. It is almost impossible to keep the oats separate. We feel, if we could cook the oats separately and feed it in with the other straw, that we'd get a lot better results from it. We have cooked oats and gotten results up to 75 or 80% of what we get from wheat straw.

MODERATOR KNACK: That's interesting. It seems you would be able to do a better job if you could handle them separately.

Well, we'll move on to the third question. I know there is a lot of interest in this: "Should agricultural residues be chopped prior to cooking, and, if so, what is the optimum stem length for best cooking results?"

I think Mr. Palm might have something to contribute.

W. H. PALM (Hinde & Dauch Paper Co. of Canada, Ltd., Toronto, Ont.): I think it depends a lot on how you're going to cook and, to some extent, on what kind of tackle you have to use after you're through cooking. There is no doubt that chopping cuts down the amount of subsequent cooking you have to do to get your stems defibered.

As to the advantage in cooking, I think the first thing you find is that you can get more uniform pulp from the digester because you can pack the digester more uniformly. Instead of having large voids in between bales or partial bales which have been compressed, you get a uniform mass in the digester. You get, I would say, less inter air to deal with. The result is, you're not involved with the same problem of relief of the digester. I think air, or noncondensable gases, is an important problem.

The consistency in the digester, too, has a great bearing on cutting versus noncutting. If the consistency is very low, you're bound to have with cutting a more even distribution of chemical—which is logical, if you stop and think about it a little bit.

Those are the main features that I can think of, offhand.

MR. GRUNWALD: How's your end result? Would you say by using a chopped straw you'd get better crush resistance than you'd get with noncut straw?

MR. PALM: I don't think it has any particular bearing from a chemical or digestion standpoint, but I would say this—that once you have reduced the length of the straw, you can use the refining equipment you have to concentrate on stock treatment instead of part of it being used in reducing the length of the stems.

MR. CASSIDAY: Do you think that has any bearing on the cooking time or the penetration of chemical during the cook?

MR. PALM: Yes, but perhaps not as much as you think, because straw is something that is fairly easy to get the liquor through anyway, being an open-stem, as it were; and once the temperature gets up, we find that the layer of, shall we say, "waxy substance" on the surface, pretty readily dissolves itself and lets you get at the fibers—a little different from wood where your resinous material is packed around each fiber.

MR. GRUNWALD: Is there any mechanical difficulty in maintaining choppers, or whatever you call them?

MR. PALM: The worst thing you have to worry about—or the worst thing we have run into—is the matter of frozen bales in the wintertime. That is something we haven't licked yet as a matter of fact. We have a lot of work still to do on that problem, but, from the standpoint of the machine itself and its ability to operate, it runs all right in the absence of blocks of ice. We had some "bugs" to iron out at the start, but the equipment we are now using, I think, answers the

purpose satisfactorily. But there has to be some means found of crushing or slicing the frozen bales from the outside edges of the pile.

The mills in a more temperate climate probably wouldn't be bothered with that same problem.

MODERATOR KNACK: Is it true that the chief advantage in chopping of straw prior to cooking is that you obtain a more uniform pulp because the chemical does get more uniform chance at the various parts of the straw?

MR. PALM: Yes, and duplication from cook to cook.

MODERATOR KNACK: That seems like that would be the logical result of chopping straw.

The second part of the question is the optimum stem length. Is there an optimum stem length?

MR. PALM: Well, again I think it depends on a lot of other factors and on just how you're going to run the whole operation.

Now Thames Board Mills, in England, operate a straw unit with the Morley process, which is similar to the chemi-pulper continuous apparatus, and they cut down to 1 in. and say that is absolutely imperative for their particular application. Our average, I'd say, was about 4 in.

The way we handle the straw, it would be a bit of a problem when you get straw too small, because we take it from the cutter to the digesters on a conveyor belt and, when you start moving pieces of straw an inch long at about 500 or 600 f.p.m. on a conveyor belt, you have a problem. It's just like so much dust. For that reason we keep the straw a little on the long side.

Another thing is that you don't get all the strands of straw cut to the same length because they don't all go through the cutter nice and straight; some go crosswise, some go at an angle, etc. So you get the odd piece that may be long. I'd say our average was about 4 in., but from the standpoint of the stock, I don't think it matters a lot.

CHAIRMAN ARONOVSKY: In using chopped straw do you use the single or multifill system, and do you get more straw into your rotary than you've been able to heretofore?

Also, has the length of your cook changed with the chemical being held the same?

MR. PALM: As some of you know, we have made a radical change in our pulping procedure in Trenton, and, once we get it to a point where we're satisfied we know what we're doing and we have a development that's worth while, we'll tell you all about it. In the meantime, I'd like to say this: that with the type of cooking we're doing at the moment, I don't think that we notice any particular difference. Speaking of your last point there, about the chemical, I don't think we can answer that directly because we have changed over entirely, our method of charging chemicals, etc.

I would say that if chopping were the only thing changed, we'd use exactly the same cooking time.

We use a single-fill system—that's the first thing—but the important thing is to pack the digester properly, and to do that you have to steam it very gently all the time you're charging it.

In other words, we put the steam on immediately as we start to charge the digester. As soon as there is enough straw in there to act as a damper, as it were, so the steam doesn't come up and hit the crew in the face, then we start putting steam on.

You'll find the straw just keeps wilting. It's amazing how much you get in. When you get done you have as much straw in with the cut straw as you do in the case of baled straw, in spite of the fact that you have created a very loose, bulky mass over something that was fairly compact when it was baled.

CHAIRMAN ARONOVSKY: You mean you get as much straw in the digester as you formerly did with two or three fills of the baled straw?

MR. PALM: That's right.

MR. KNAPP: How do you lead the steam into the digester?

MR. PALM: We have a pipe that we lead from the trunnion down to the bottom, or to the periphery of the sphere.

MR. KNAPP: Inside?

MR. PALM: Inside. That is welded to the inside of the shell. That enables you to disseminate steam around the whole mass from the bottom, when standing in a stationary position. But you always have to stop the digester with it at the bottom—that's the important thing—or install it directly opposite your opening.

MR. KNAPP: Do you have any trouble with plugging in your globe?

MR. PALM: No. I'll tell you this, though, that if you're using lime, I certainly wouldn't recommend it. It will plug tighter than a drum.

Any of you fellows who are using sodium sulphite or soluble chemicals—in other words, that do not have any lime involved in their combination—you would be all right. Lime has a nasty habit of building up a crust, as it were, that just naturally closes everything. Some of you may have observed that before in your own operations.

ARTHUR W. INFANGER (The Cowles Co., Cayuga, N. Y.): This might be of interest—I don't know; I'm not too familiar with your usual processes of pulping and defibering straw; but we have done some preliminary work on it in our Beata-pulper, and we have found that, by feeding chopped straw or full-length baled straw, the entire mass is pulped in less than 5 min. It is reduced so that it makes hardly any difference how you furnish the material. We add in our process, steam and hot water, and the chemical action combines more or less to give you quite a rapid treatment; and obviously there would be no danger of any concentration of chemicals in any one spot in such a process.

I think that has been done previously, but we have tried to apply it to our own unit. We have found that in using chopped straw versus full-length straw, the difference is so slight as to be negligible.

MR. CASSIDAY: What is the length of chopped straw?

MR. INFANGER: From 2 to 2 1/2 inches.

MR. CASSIDAY: And how is it chopped?

MR. INFANGER: With a regular silage chopper.

MR. CASSIDAY: I would like to ask whether Mr. Palm thinks that this same wetting action could be accomplished by wetting the chopped straw down with, say, black liquor from a preceding cook, as the digester is being filled?

MR. PALM: I would say definitely not. I don't think the temperature of the liquor you were using would be up to that of steam, and I think you need the temperature there to help you.

CHAIRMAN ARONOVSKY: Do you feed the liquor in directly with the straw, or do you put it in first, or afterward?

MR. PALM: We charge the digester fully, first with straw. I think that if you charged black liquor or new liquor with the straw, you'd start to get nonuniformity, because you partially cook some of the straw or some of it would absorb more chemical than the rest of the straw.

MODERATOR KNACK: Anyone else have anything on straw-chopping?

MR. CASSIDAY: Would it be possible to chop the straw so short that it would impair the yield—say, for example, if you got the stem length down to less than a half inch?

MR. GRUNWALD: I think you would have a dust storm.

CHAIRMAN ARONOVSKY: I think you would have a reduction in yield. You would certainly have a reduction in strength if you chopped the straw down to a half inch. After all, chopping straw is like chipping wood; every time you cut, you cut some fibers.

MODERATOR KNACK: Well, I think we'll leave the subject of chopped straw. We have a dandy here—the next one. It's a subject that could very well occupy an entire session:

"From the standpoint of the highest resultant flat crush strength after corrugating, what is the best cooking chemical combination, concentration, water ratio, temperature, pres-

sure, and time for cooking the following agricultural residues for use in the manufacture of 9-point corrugating medium: (a) wheat straw, (b) oats straw, (c) soybean stalks, (d) bagasse."

That "covers the waterfront."

I think perhaps instead of trying to break down the cooking formulations for all these various raw materials, we might ask, what chemical formulations are being used in an attempt to get high flat crush and the resulting corrugated board?

Does anybody care to tell us what he's doing with neutral sodium sulphite?

MR. GRUNWALD: Mr. Knack, don't you think Sam's experimental cooks that he made at the laboratory would give you the answer? He certainly gave, in great detail, cooking formulas and results obtained.

CHAIRMAN ARONOVSKY: They were all based on wheat straw.

MODERATOR KNACK: Well, I think most of us are attempting to do something with our cooking formulations in an attempt to get a pulp that will give a higher flat crush. What the best chemical combination is, I don't know. I think that perhaps even if we did know what the best combination was, the mill still would use a combination that they'd developed themselves, because they have to produce a pulp that they can adapt to their own equipment. Some mills are long on refining power, so they cook a raw pulp with the intention of using a lot of power in refining to produce stiffness in the sheet. Naturally that mill would use a different chemical combination, concentration water ratio, and all these other things, than another mill, being short of power, would use to produce a pulp that was rather better cooked.

I don't know if anybody wants to discuss their cooking methods.

CHAIRMAN ARONOVSKY: I don't think it is necessary to give the percentage of chemicals used; but from the standpoint of the discussion, it would be desirable to give the relative proportions, such as more caustic, less sulphite, etc., in order to get just an idea of the changes required for the different raw materials.

One thing I'd like to know is how many mills are still using lime.

N. HARRY CARPENTER (Muskingum Fiber Products Co., Coshocton, Ohio) We are.

MR. LITTLE: That seems to me one of the essential things in improving the flat crush; to reduce the amount of lime as much as possible. We use lime but try to use as little as we can.

MR. CARPENTER: I'd like to ask this question in connection with sulphite. We find some difference in the quality of material. We have one supplier who supplies us with sulphite that has all the colors of the rainbow, and another that supplies us on a fairly pure material, but it's wet and consequently it gets hard. I understand it's a product of a phenol derivative and in this dark brown product we get a lot of material like coal tar, and it has some effect on the machine.

I wondered whether anybody had any difficulty in getting coal tars out of their sulphite?

MR. CASSIDAY: We have used both the fusion grade and Santosite, as Monsanto calls it. Of course the fusion grade has the higher phenol content, I think it has 9 or 10%, but I never recognized any particular difference between the two materials. Of course you have to take precautionary measures, in using the fusion grade, that the temperature in your storage doesn't get lower than about 40°, otherwise the material is liable to cake and become very hard.

I have discussed that with Monsanto and they say they don't know just what causes it. Some batches will become very hard and others just form a thin crust over the product that is very easily broken up.

MR. CARPENTER: We see a great deal of difference with the two products in color of the liquor; actually, one is almost soupy.

MR. CASSIDAY: It seems to me that too little regard has been paid to the actual pulping of wheat straw and too much to machine operation. I think we should be producing pulp for pulp and not for a paper machine, and then learn how to run it.

We are using a sort of kraft-sulphite process in our cook, you might call it. We have given considerable thought to a neutral sulphite cook, but have heard that the pulp produced by it has a lower freeness. On the other hand, does the neutral sulphite pulp yield a higher flat crush strength, speaking of wheat straw, than that produced by, say, a kraft semi-chemical cook?

I was wondering whether there was any information available along that line—whether anybody has any data on it.

MODERATOR KNACK: Does anybody have any data on the relative flat crush strength that can be obtained by a neutral sodium sulphite cook as opposed to a kraft cook?

I think, in general, the neutral sodium sulphite cook has been shown to produce higher flat crush results than lime or lime-caustic cooks; is that correct?

CHAIRMAN ARONOVSKY: Yes.

MODERATOR KNACK: But I don't know that we have any comparative data on the neutral sodium sulphite cook versus this other cook to which you referred. What chemicals are you using in that sort of cook?

MR. CASSIDAY: Caustic soda, sodium sulphide, and sodium sulphite.

CHAIRMAN ARONOVSKY: Our experimental work shows that the strong alkalis give the higher crush test. Under the same conditions of cooking, they also give a lower yield of pulp. However, I don't mean to imply that we have exhausted the possibilities of these types of chemicals in cooking; we just took a certain number of conditions and compared the pulps made under those conditions.

Now it is very possible—and I think very likely—that you can get equal crush resistance from either of these types of chemicals by finding the correct conditions.

With regard to what you said about slowness, referring again to our experimental results the neutral sulphite pulps in general are relatively freer than the alkaline pulps. When you obtain slowness in a neutral sulphite corrugating pulp it is due, in large part I think, to the fact that the neutral sulphite pulp fibers are somewhat more brittle at that particular stage of cooking than the alkali-cooked fibers, and therefore produce more debris in refining. Some of that is borne out by some classification tests that we have run; the neutral sulphite pulps, cooked to the same degree as the alkaline pulps, are not quite as flexible as the alkaline fibers.

MR. CASSIDAY: Did Mr. Lathrop say earlier it is his feeling that the hemicelluloses as a whole are more important in obtaining high flat crush than pentosans alone?

MR. LATHROP: Well, if I may make a remark about that, I use the terms "pentosan" and "hemicelluloses" more or less interchangeably. They're not actually interchangeable, but the determination we make, of course, is a pentosan determination, and I think pentosan content is a fairly good indication of the ability of these materials to produce stiffness.

I don't want to imply in that connection that lignin has no part in this matter, but I did say, Mr. Cassiday, that I thought that until the hardwood people applied methods which gave very high yields which, in turn, preserved the hemicelluloses, that they weren't able to make a very rigid corrugating.

MR. CASSIDAY: Well, then, would there be an optimum cooking liquor combination that would yield the highest hemicellulose or pentosan content of the resultant pulp? Would a neutral sulphite cook yield a higher content than a kraft cook or a kraft-sulphite cook?

MR. LATHROP: We haven't explored this matter of pulping far enough to answer that question finally. Actually, I referred in my opening remarks to the fact that there is some difference in approaching the two problems, one in

which you have a great deal of tradition and background, and the other in which you have very little old tradition.

I think the hardwood people have had a distinct advantage in having research started out without any tradition to forget while, on the other hand, this straw problem is a very old one. I think if we could start out and forget all that we know about straw pulping, we could probably make progress faster than we have.

I believe that optimum cooking conditions can be found to produce the pulp you wish, and I think that the better the pulping conditions, the more likely it will be to produce such a pulp.

MR. CASSIDAY: That would be a neutral sulphite cook, then, wouldn't it?

MR. LATHROP: Not necessarily. Temperature, concentration, and other factors are naturally involved.

MR. CASSIDAY: Until we know the answer to that I think we are still groping around in the dark in producing a 9-point of a high-flat crush, and it behooves us to get up to date and learn how to do these things.

CHAIRMAN ARONOVSKY: I might add to that, when you compare cereal straws with hardwoods for corrugating, for instance, the straws contain more pentosans and the woods contain more lignin. In the semichemical process relatively little of the lignin is removed and, when you compare the two pulps, the wood pulp still contains more lignin.

Now whether lignin has any role, or how much role it has, we don't know yet. I hope that is, as Mr. Lathrop mentioned, one of the problems that will be studied in connection with our TAPPI research project.

MR. MARTIN: Several years ago we were experimenting on rice straw and wheat straw with sodium sulphite and lime in equal amounts—2% of each—and the results were very good considering the small amounts of chemicals that were used. I wonder if that cooking formula has had any mill experience since then.

CHAIRMAN ARONOVSKY: Mr. Little, can you say anything about that? You've tried out that at Fort Madison, haven't you?

MR LITTLE: Yes, I tried it out. I think it gives a much rawer cook than we are used to handling. We could get by with it for a little while but it was too raw for us; we couldn't handle it.

CHAIRMAN ARONOVSKY: One of the difficulties encountered in discussing the effects of chemicals on pulping is that every mill has different refining and handling equipment and what is good pulp for one mill may not be good for another.

In other words, the pulp handled in your mill with the existing refining equipment might have behaved differently with other equipment.

I understand that in one of the South American countries a mill has been put up to cook bagasse and straw with just those chemicals and concentrations. I don't know how far they're along, but a preliminary report I got from their laboratory about a year ago indicated that they seemed to get a suitable pulp that way.

MR. LITTLE: I think if you cut the straw first and then had the right kind of tackle, you could probably get along.

MODERATOR KNACK: I think that Mr. Cassiday has hit on the root of this matter when he said that we'd better learn how to make the best possible sort of pulp from straw and then adapt our equipment to run that pulp, rather than to try to produce a pulp that fits our equipment.

We are all concerned with the low yields that we're getting and with the flat crush qualities of the resulting product. We should find out how we can produce the most economical pulp from straw that will give us the qualities we want from the pulp, and then get equipment that will run it. I think that is the answer.

MR. KNAPP: Going back to this hemicellulose or wood-sugar content, I've toyed with the idea for quite awhile—the relation of straw to Mitscherlich sulphite cooking. If we could get away from the tradition that we've been doing it this way for 30 years, there's a lot to be considered. The Mitscherlich cook, as you probably know, is a long, slow cook. It depends on these wood sugars to get the fast hydration and high strength. The Mitscherlich people don't hold that lead now, as much as they used to before the advent of stainless steels and the circulation of sulphite liquors, but they do keep those wood sugars in, and I wonder if we couldn't give the straw a gentler treatment with the idea of retaining more of the hemicellulose materials.

We may be getting to a point where we're going to cook a little more gently. We're thinking of using 30 lb. of steam instead of 50—even possibly with the same length or longer cook than we are using now. Everybody may not be as fortunate in having a bunch of rotaries as we do: we have 30 rotaries in our mill. We are really blessed with them.

But there is a lot to think about on retaining these wood sugars in the pulp.

MR. LATHROP: Mr. Chairman, may I speak about this from a fundamental viewpoint? I think that's the way to approach it.

These so-called "hemicelluloses" are very much smaller, molecular-wise, than cellulose. The polymerization degree probably doesn't exceed 150 and it is probably less than that, while the cellulose can be gotten from straw and from wood around a DP of 1200 or more.

We know from the immense amount of work that has been done in connection with polymers that you have to get up to a certain size of polymer before you begin to have fiber characteristics, and there is some relation between solubility (and I'm not using the work "solubility" in its true sense when I say that) and molecular size. That is, the larger the molecule, the more it tends to be insoluble in all sorts of reagents.

I think we know pretty well, now, that hemicellulose constituents have a great deal to do with our ability to "hydrate" our paper pulps. We know that if we isolate the pentosans themselves from straw, corncobs, or any of these plants, they always dry to very horny, hard substances. That is their characteristic. And we know that the paper pulps that we make from straw, from bagasse, from some of the hardwoods, all hydrate nicely.

Going one step further and referring to some of our own work at the Laboratory, we have been able to make fine paper pulps that have a higher content of pentosans than the material from which they started. That is true of straw and true of bagasse. These results are obtained by use of the mechano-chemical pulping process. In this process, the temperature doesn't exceed about 200° because it is carried out at atmospheric pressure. The concentration of alkali is no larger than we use in the autoclave to produce not so strong a pulp at 100 lb. pressure. Of course, we know that the more rigorous our chemical action, the more likely we are to break some of these chains of the celluloses and hemicelluloses. The first thing we are going to break is the hemicellulose chains. They're much easier hydrolyzed than the cellulose. A high concentration of caustic will dissolve a lot of the hemicelluloses in straw.

So I think you put your finger on something that is very important . . . (indicating Mr. Knapp) . . .

The reason why I've stressed so many times the importance of the hemicelluloses is because of these fundamental considerations I'm mentioning, and I think the difficulty, in approaching some of our problems, is that we do not consider fundamentals. If we know our fundamentals, we can predict many of the things that will happen.

I am rather interested, Mal: last year the question of soybean straw was of vital importance, and this year nobody is interested in it. Evidently, it was not a fundamental question in this important research. It was one of these things that was very important, from an industry standpoint, but, for the long pull, it wasn't very important.

MR. LITTLE: When we started using liquid caustic this year and made the change from lime and soda ash to liquid caustic, we found we were getting much more variation within a cook and between cooks than with the soda ash. We finally worked out a way to reduce the variations in cooks to a minimum: we put a $^3/_4$-in. orifice in our steam line in order to cut the speed at which we were heating the digester, and bring it up to temperature slowly. We cook, ordinarily, with 50 lb. steam, and our habit was to turn the steam on pretty much at once to bring the temperature up within 15 or 20 min.

When we did that, we'd cooked part of it and part of it would be raw. When we put an orifice in the line the 3-in. valve was kept closed and cooking was done with steam entering the digester through a $1^1/_2$-in. line with a $^3/_4$-in. orifice in it.

We found that would even up our cook a lot. We still have some variation, we still have some cooks that are on the raw side, but the uniformity is much better than before. It takes us about 2 hr. with a $^3/_4$-in. orifice to bring the temperature up to 212°, and then, at the end of our cook—which in the summertime, is around 5 hr., the pressure is about 40 lb.

CHAIRMAN ARONOVSKY: John, I think you've hit on a very important point in pulping straw or any other materials for corrugating. When we had the old lime system, whether we used lime alone or lime and soda ash, where the major chemical was lime, you had, really, a very easily controlled system. Lime is not very soluble and therefore you have a saturated solution all the time. No matter how much lime you have in your rotary, you still don't have more than a saturated solution of $Ca(OH)_2$ in there at any one time.

Now, in multifill systems particularly, you'd add your chemical at your first fill, and that straw would pick up lime. As you added more straw and as lime was removed from the solution, more lime would dissolve and the straw would still have a chance to pick up its chemical. However, when you start using these more active chemicals, such as sodium hydroxide and even sodium sulphite, and use a smaller amount of chemical based on your straw, you run into a different situation.

To put it crudely, straw is very hungry for alkali, and the first straw will grab all it can and, in general, a major portion of the alkali. The last fill, or even the straw that goes in last to the digesters, will have to compete and take alkali away from the straw that has already gotten it, and, as a result, you get a nonuniform cook.

By using lower temperatures and lower pressures, you're getting away from that to some extent because the affinity of alkali for straw is not nearly as great at the lower temperatures as it is at the higher temperatures.

I think you've hit on a very important point in pulping for corrugating where you're using a relatively small amount of very active chemical. In other words, you have to in some way—maybe Bill Palm has the right method—get all the straw into the rotary, put in the chemical with all the solution you're going to use at one time, and get it distributed that way.

MR. KNAPP: I don't want to disagree with Sam that it doesn't make any difference, but since September we have run quite a quality-control program in Weston. At present we are using the four-fill system. I don't know how we arrived at it, it just seems to work. But when we started, we started adding the caustic and Santosite (we use about equal amounts) all on the first fill.

Well then, according to theory, the first of the straw gets more treatment than the last fill. So we tried splitting our chemical, adding half of it on the first fill and half on the last fill, and we couldn't see that it made a bit of difference on the main operation. We got into more trouble trying to get the chemical all in that way than we figured we got any benefit from it. We do finish our cooking at a relatively high pH. We find we get more uniformity in cooking at a pH around 9 rather than running it down somewhere around the neutral point.

There is no question there is more variation with caustic than with lime. When we first started cooking at a pH of around 7 or 7.5, our flat crush curve was all around the place. We'd run 30 to 60 p.s.i. on single flute test in 4 or 5 hr.

MR. CASSIDAY: Have you made any study on the alkali in the rotary or how rapidly it is exhausted?

MR. KNAPP: That is another problem on which we were very much surprised. When we started adding all our liquor at the first fill, we started checking the pH; at the time we blew down for the fourth fill, we found the pH was around 10 or 11. We only lost from one to one-and-a-half pH units in the balance of the 8-hr. cooking.

We don't know why, but it's interesting. We haven't gone into the chemistry of it, but there is a terrific amount of action the first few minutes the liquor is in the straw.

MR. CASSIDAY: We make only one fill and put all the liquor in at one time, and the few spot-checks we have made show that the active alkali is all consumed within the first hour. Most of it is gone even before we get up to pressure.

I wounder just what is happening in the digester during the rest of the cook—whether we are destroying some of the desirable components of the fibers, pentosans, for instance.

CHAIRMAN ARONOVSKY: Well, is your active alkali actually gone? It's gone from the liquor, but it's in the straw; it's been absorbed by the straw, and, of course, as you continue cooking it's the alkali on the straw that's doing your cooking.

Within that range, in the range of 10 to 11, pH is a rather dangerous unit to use as a measure of the alkalinity, because the concentration can vary a whole lot and you're still within that pH range.

MR. KNAPP: That is true; pH isn't the answer to cooking straw, but for mill operation it gives us something that is simple and something that the man in the rotary room can handle without a lot of training.

CHAIRMAN ARONOVSKY: What pH do you have when you discharge your digester, or at the end of your cook?

MR. KNAPP: We try to maintain between 9.5 and 9.6. That sounds kind of high, but we feel we get a more uniform cook at that pH and it is a lot easier to refine and to handle on the machine.

CHAIRMAN ARONOVSKY: Could you tell us as to the approximate amount of caustic you add, based on straw?

MR. KNAPP: Three to four per cent, about an equal percentage of caustic and Santosite.

MODERATOR KNACK: Well, I think we had better move on. We seem to be agreed that something needs to be done in the way of fundamental research, here, to find out what the best sort of high-yield pulp is we can produce and, accordingly, the Committee has asked TAPPI for a grant to pursue that sort of research. Providing the grant is allowed, perhaps we'll be able to uncover some of the answers to this question.

The next question asked is: "What process, commercial or of potential commercial importance, is best suited to the manufacture of fine papers from straws including cereal straws?" Does anyone care to discuss the processes in common commercial use or potential commercial use for the production of fine paper?

Mr. Palm mentioned this process in the English mill that is called the Morley process.

MR. PALM: It's the same as the process they're using on hardwood.

MODERATOR KNACK: That is not a fine paper process.

CHAIRMAN ARONOVSKY: No, that is not a fine paper process.

MODERATOR KNACK: There is this Italian process.

CHAIRMAN ARONOVSKY: There is the familiar Pomilio or Celdecor process being used in England, Argentina, Holland and originally in Italy. I understand there is one mill going up in Brazil and there is a small mill using the process on

bagasse in the Philippines. A mill in Algiers uses both straw and esparto.

Then there is another process put out or developed by Kamyr of Sweden—a continuous process for wood chips—and our understanding is that a mill built just outside of Paris, France, for wood, is set up to pulp straw in the same unit.

There are, of course, a number of processes used in Europe in small family-owned mills; you might be interested in one, and that is the Marsoni process. They put the straw with about 10% caustic soda into a pit, and let it stay there for about 15 days. Then they take the straw out and wash it and make an excellent glassine paper out of it.

The neutral sulphite process is being used, particularly in Italy, Holland, and France for making fine pulp from straw. It's a full chemical cook although they use less than the amounts required normally for wood in making a semi-chemical pulp. And then we have developed a process which has commercial possibilities and indicates that a very good pulp can be produced, and that is this atmospheric pulping method that Mr. Lathrop mentioned

There are, of course, a number of different types of processes being used, particularly in those small mills in Italy and France making anywhere from 5 tons a week to 10 or 15 tons a day, all family-owned and family-operated; each one has developed its own process, but most of them are based on caustic soda.

Mr. Lathrop: Mr. Chairman, I was talking to Mr. Atchison yesterday afternoon who told me that there are, now, three market pulp mills in Holland. One uses this Celdecor process. And he said that was arrived at because the company was in a rayon business, and had a lot of extra chlorine and caustic, so that Celdecor was the most economical process for them. He said they're making an excellent pulp.

The second was a kraft process with complete recovery.

The third was the mono-sulphite process.

Each of those would have a capacity of bleached pulp of about 30 tons a day. He said there were three plants in Germany, two of them were integrated, one of them is making market pulp, and they're all using the soda process.

As you know, he has just come back from Europe, so I think that is the latest information on the situation over there.

Moderator Knack: Anyone else have anything to offer on fine pulp processes?

H. H. Brown: (Consultant, New York, N. Y.) I'd just like to mention that Mr. Aronovsky suggested that in Brazil there was a Pomilio mill going up to use both bagasse and straw. I was in Brazil and talked, less than a year ago, with the people who were financing that operation, and it is to be entirely on bagasse, not straw. It is being put up by some sugar interests and they're interested solely in fine papers and that's what the mill is designed to make, on a 50 tons per day basis.

Chairman Aronovsky: Thank you.

Moderator Knack: Well, I think that pretty well covers the fine paper production from straw, and the processes as well as the recent foreign developments in straw pulps, which is one of the other questions that was asked.

Now we come to a question which most of the mills are considerably interested in: "As the mills use a chemical in processing which will provide higher flat crush, do they sacrifice much in yield?"

What is your experience on that, Earl?

Mr. Knapp: Our management is very much concerned with our low yield. There is no question but that the caustic-Santosite cook is a lot more drastic than either straight caustic or lime-caustic.

We find, in our rotaries, around 125,000 p.p.m. in total solids on caustic Santosite. On the old lime cook, we'd run around 75,000. We also run a lot more solids in our sewers, too, than we did on the other. So there is a portion going out, there, but some more being lost some place else, too.

Mr. Grunwald: At the present moment we are more interested in flat crush than in the matter of yield. That is not nearly as important, today, as it was several years ago.

Moderator Knack: Don't you find that as you cook with chemicals to produce higher flat crush, your yield goes down?

Mr. Grunwald: Definitely—15 or 20%.

Moderator Knack: That's been our experience.

Is your experience in line with that, Bill?

Mr. Cassiday: I'd rather not say. We have no way of determining actually what our yield is. I wish I could figure out some way of doing it. But it seems to me, as we learn more about the proper way to cook straw, we should be able to increase the yield using a less drastic cook and more refining.

Moderator Knack: I think that's a definite possibility.

Mr. Knapp: Mal, I think Fritz has the idea, there: we should come to a definite standardization on straw grading. There is no question but that is a part of where our low yield is concerned.

Moderator Knack: I think that is very true and probably explains the general trend to lower yields.

Up in Canada you don't have that problem, do you, Mr. Palm?

Mr. Palm: We sure do. Lots of weeds and lots of water. It is my opinion, though, that we are losing a lot more than we think we are, from the straw pile to the mill, due to factors other than these that have been mentioned. We are in the process of making an investigation on that right now, and we hope to have some figures on it. I don't know whether it will be relative, because location has something to do with it; but there is no doubt there is a heck of a lot of deterioration takes place between the pile and the mills, which represents lost yield, irrespective of the factors of moisture and all the rest of it, all of which contribute to it.

I agree with Fritz 100% on that. But I think we have a lot of work to do on that particular thing, which comes back to the studies made on borax, etc. That helps, there's no doubt about it. But I think there is a lot to be done on trying to segregate sound straw from unsound straw, and pulp them entirely differently. You can pulp unsound straw with hot water and not another darn thing. It's something we have to think about.

Chairman Aronovsky: I would like to add a couple of comments.

It has been suggested by several members of our Committee that one of the subjects under discussion for our next meeting be specifications and grading of straw; and I think it is an excellent subject. We are going to try to have our meeting in the Fall when the straw buyers are free from their work and they can come into this discussion.

Now, going back to low yield, you will all recall the paper that was given several years ago in which we made the various types of cooks, including the standard lime-caustic, straight caustic, straight sulphite, caustic-sulphite, and sulphite carbonate; and I have here the yields we obtained on those cooks under exactly the same conditions with no change except in the type or the amount of chemical.

The lime cook gave us 75% yield of washed pulp. That is, of course, a laboratory operation, but this was all done on the same batch of straw.

The caustic cook, 6% caustic, gave us 64% yield, a difference, there, of 11%. That was the most drastic of our cooks but it still doesn't come down to the 50% or less that was reported the other day.

The 10% sulphite cook, which is a lot more chemical than any of you use, gave a yield of 67%.

The 2% caustic and 4% sodium sulphite gave 70%.

The 2% sulphite and 2% soda ash gave 71%.

So I'm inclined to agree that there is something more than an actual loss of material due to the type of cooking you're doing now, because this was all done on the same type of straw, taken from the same batch and blended before we made any of these series of cooks; so our conditions, here, are comparable.

With our standard 6% lime–1½% caustic cook in our laboratory, we always obtained between 72% and 74% of washed straw pulp under our conditions of cooking and washing pulp. As I've said here many times before, I think that the mills have obtained similar actual yields of pulp in their digesters, but when you start figuring your shrinkage from the straw you buy to the paper you make, you do end up with a considerably lower yield.

MR. LATHROP: I just want to ask one question. Doesn't part of that difficulty come in your wastepaper situation? You think you know how much you're buying, but you have a lot of junk in it and you don't know exactly how much wastepaper goes into process, do you?

That is one of the factors that is still uncertain.

MR. GRUNWALD: The shrinkage in wastepaper is "peanuts" compared to the shrinkage in straw.

MODERATOR KNACK: We know we have a rather better check on what our normal shrinkage loss should be on wastepaper than that on straw. We know a little bit more about that.

I think most of us are rather poorly set up to determine what our shrinkage actually is. I know a lot of factors in our mill are not properly separated. Our shrinkage information isn't too accurate.

MR. PALM: I think what you say is absolutely right. We have done a lot of checking on this business of digester conversion because we knew there were a lot of other losses taking place, weight, water losses, etc., which we have been trying to pin-point to get to the root of these individual items, and we have used a method under which we get comparative check results. The group might be interested in getting such results, or maybe they have already tried it themselves. We have used a very coarse, open-mesh bag like these onion bags used for vegetables and stuff, and you put about 25 or 30 lb. of straw in it, tie a rope on its end and fling it into the digester. When you dump the digester, you pull out the bag and weigh it. Thus, you can watch that straw and check it, and you can certainly get a pretty accurate yield determination.

We have made check after check and we get comparative results; change of yield by varying the conditions can be picked up by that method.

MODERATOR KNACK: That's an interesting method.

MR. PALM: Yes. And we find that our digester conversion isn't anything like the kind of loss we are talking about today, and that is why I made the previous comment that I did. There is a heck of a lot happening between the straw pile and the mill. That's where the biggest part of the drop is, in my experience.

CHAIRMAN ARONOVSKY: Do you agree, then, with the results shown in our study?

MR. PALM: They're practically the same as we get in the mill—yes. You can get it before washing and after washing.

MODERATOR KNACK: Well, that is probably enough discussion on yield. We pretty well covered the subject of cooking and probably better move along and see what we can do on stock preparation. In spite of the best we can do, we are going to have some things left over.

One of the questions asked on stock preparation was the best method for preparation of soybean stock. We have talked about that a little bit but not with particular reference to stock preparation.

Has anybody done any new work on stock preparation of soybeans—treating them separately?

MR. GRUNWALD: I thought we discussed that. Nobody seems to be too much interested.

MODERATOR KNACK: We'll pass that over and discuss the next subject, which is, "refiners versus beaters in preparation of straw pulp."

The subject of "refiners versus beaters" usually involves stock handling methods as well, and starts back as far as Mr. Palm's straw-cutting system. If you take your straw out of your cookers in such condition that you can pulp it and handle it, you can wash it and refine it by methods that aren't so successful if you dump your bales into the cooker and take them out without any cutting at all.

There are some mills, I know, that don't use beaters in the preparation of their straw.

Would you care to discuss the methods that you use, Mr. Zinkil?

G. A. ZINKIL (Central Fibre Products Co., Quincy, Ill.): We are in no position to discuss beaters because we don't have any, anymore. We do all our refining job—in one Sutherland refiner, a Jones Fiber-master and jordans. I think we have gotten away from the old type beater. Whether it's right or not, we'd like to know, too.

MODERATOR KNACK: Well, you were able to accomplish the refining without using any washers or beaters through the use of sugar presses; is that correct?

MR. ZINKIL: That's right.

MODERATOR KNACK: John, are you still using beaters?

MR. LITTLE: Yes, we're using beaters. I think, it's largely a question of being able to handle the stock through some sort of refiner.

MODERATOR KNACK: How do you accomplish your washing, John?

MR. LITTLE: Right now we're doing very little washing, only enough to control the consistency.

At Trenton, Ontario, we have a "tug boat" and do have washers in that, but the purpose of the washers, now at least, is to bring the consistency down there when they fill it. Of course they pump the stock directly from their rotary pit into the "tug boat," and some washing is done to remove excess water and to control the consistency.

MR. ZINKIL: Our machines are run strictly on an open-system and I think that makes a lot of difference. The amount of water which we use is very high which also plays hob with the yields.

MODERATOR KNACK: Do you still do some washing on the sidehill screen?

MR. ZINKIL: Somewhat. That particular part of the system is closed up, but from there on out it's pretty wide open.

MODERATOR KNACK: Do you think that most of the washing is done on the paper machine?

MR. ZINKIL: Yes, at the present time.

MODERATOR KNACK: Does anybody have anything to say on the question of refining beaters versus refiners?

MR. GRUNWALD: We're using beaters, but primarily for washing. We have never been able to make any kind of a straw with beaters as well as we do with refiners. We continue to use washers but use less power on our beaters.

How about yourself, Mr. Knack?

MODERATOR KNACK: Well, we still use beaters and washers. We do get our straw pretty well defibered in the beaters as well as washed. With the cook that we are using at present we get our straw rather well washed in the beaters, and, unfortunately, the way our mill is arranged we have to break our wastepaper in the beaters. We are hoping to correct that, but we will continue, at least for the present, to use beaters.

Do you have something to add to this discussion, Bill?

MR. CASSIDAY: No, I don't think I have.

I'd like to ask whether Trenton is using disk refiners.

MR. LITTLE: No, they're using a Shartle refiner.

MR. CASSIDAY: Do you use a disk refiner, George?

MR. ZINKIL: We are not using it to the best advantage according to the rules. We are putting more stock through than you would if you wanted to get 100% disk refining.

LEE EBERHARDT (Bauer Brothers Co., Springfield, Ohio): I have a comment on this washing problem. We have some indication, in our laboratory, that cooked straw that had been chopped previously to cooking in a rotary washes very well on a vacuum filter. We have an Oliver filter at Spring-

field and got good washing on cooked straw just as it came from a digester. It looks like vacuum washers might work quite well at that point in the system.

CHAIRMAN ARONOVSKY: It is our understanding that all of the European pulp and paper mills which produce a coarse type of straw pulp for use both in corrugating and coarse wrapping papers use vacuum washers successfully.

MR. EBERHARDT: There is one thing we did notice about vacuum washing, if you do very much refining on straw pulp, the stock slows down so much that you run into a lot of difficulty on a vacuum washer. You have to keep it as free as you can.

MODERATOR KNACK: Anybody else on "refiners versus beaters?"

MR. GRUNWALD: Yes, I'd like to ask a question. What is the experience, jordan versus Sutherland, on straw pulp?

MODERATOR KNACK: Do you have enough capacity through a Sutherland refiner, now, to that machine, George?

MR. ZINKIL: No.

MODERATOR KNACK: Do you use the Sutherland and follow it by some treatment?

MR. ZINKIL: Yes.

MR. GRUNWALD: Do you do the same work in the jordan as the Sutherland?

MR. ZINKIL: No, I don't believe we do. You do a lot more cutting, which straw doesn't need in the jordan. I think you get a lot more defibering in the Fibermaster than you do in a jordan.

MR. CASSIDAY: Is there any relationship between the degree of refining and flat crush? Your degree of cutting, say.

MODERATOR KNACK: I should think there no doubt would be. To put it another way, I should think that the type of refining used would have a definite effect on flat crush from the same pulp. I don't have any data to support that.

MR. LATHROP: It seems to me, Mr. Chairman, that what you want to do is hydrate your pulp and get your slowness that way. If slowness is brought about largely by cutting, swelling and consequent shrinkage of the fibers on drying will not be so great, between those two actions, e.g., hydration and cutting.

MODERATOR KNACK: As I pointed out at the committee meeting we had on Monday, there are two qualities in straw in which we are primarily interested: one is high flat crush, and the other is runability. There is probably a third—fatigue resistance—that we don't know much about, but it will probably be some time before we know about that.

MR. GRUNWALD: At this very moment we are conducting some experiments along that line. We use more jordans than in the past. We have only done it a short time, so there is nothing conclusive about it, but it showed tendencies of increasing the flat crush, decreasing the machine speed and decreasing the runability on corrugated; but it did increase the flat crush.

CHAIRMAN ARONOVSKY: Fritz, on the basis of laboratory studies, where we are not concerned with runability, there is a definite correlation between increased refining and crush tests; it goes right up with refining.

MR. GRUNWALD: Yes. That is what we found. But it did decrease machine speed and runability.

MR. KNAPP: On your increased jordaning, didn't you actually use less horsepower per ton?

MR. GRUNWALD: We used twice the number of jordans we used in the past. It is strictly an experiment, that's all it is. It is very inconclusive.

MR. KNAPP: But that goes back to the same principle on linerboard. You can get your better strength by actually defibering instead of cutting your stock.

MR. GRUNWALD: That is correct.

Another experiment I've been making is changing the widths of jordan bars. I find 1/4-in. bars do better than 5/16 or 3/8 on straw.

MR. KNAPP: It depends on where they are. We feel that, on the first jordan, if we have a 1/2-in. bar it gives us better results. There is more crushing action. Then use the narrower bars for finishing.

MR. GRUNWALD: That's what I mean. On finishing, it doesn't make sense, but that's been our experience—1/4-in. bars.

MODERATOR KNACK: Well, I think we might move on and just briefly touch on paper making.

The reason why I'm anxious to get at this is that there is a question in which I'm considerably interested. The question is: "Do mills in general which are endeavoring to produce a sheet of straw 9-point which will provide high flat crush have difficulty in removing water from the straw and in drying?"

What is your experience on water removal on the machine?

MR. GRUNWALD: The slower your stock, the harder it is to remove water at the wet end of the strawboard machine.

MODERATOR KNACK: I think that is true whether you produced the slower stock by changing your cooking methods or whether you do it mechanically. It probably isn't true to the same degree.

Has anyone tried running a short top felt on a straw machine in order to be able to press more heavily to get some additional water removal?

MR. ZINKIL: Ask that question next year.

MODERATOR KNACK: Thank you.

We are having considerable difficulty in getting the sheet over the driers in the condition that we used to. It is quite troublesome. It's an operating problem that bothers our fellows. They would like to try a top felt and see if they could do any better with it. It would probably introduce some more problems—another felt to keep clean.

CHAIRMAN ARONOVSKY: I'd like to ask a question in this regard. Has anybody tried to control the pH of the stock that comes onto the paper machine with respect to its drainage and drying characteristics? As I understand it, at one mill where they have a more or less completely closed system, they neutralize the excess alkali in the stock before it goes on to the paper machine.

Does that tend to free up the sheet and give you better drying?

MR. GRUNWALD: Years ago I added sulphuric acid; it makes the sheet black but definitely frees it up. You can't use sulphuric acid commercially, it's hard to use and one couldn't buy enough alum to neutralize the stock. The neutral stock would be freer, absolutely.

CHAIRMAN ARONOVSKY: I was thinking particularly, Fritz, of not getting it over to the acid side but to a pH of 7 or 7.5.

MR. GRUNWALD: That's exactly what we did: a pH of 8. The amounts were terrific.

CHAIRMAN ARONOVSKY: Would you still need the large amount of sulphuric acid in your present operation?

MR. GRUNWALD: I don't know; we haven't tried it.

CHAIRMAN ARONOVSKY: It might not have any effect on your flat crush and still give you better runability.

MR. GRUNWALD: But under runability, now, when Mal speaks of runability he also means corrugators.

MODERATOR KNACK: Yes, runability on the corrugator; that is a quality of strawboard we don't measure, but we do a lot of talking about it.

MR. KNAPP: We have done quite a bit of experimenting on the use of alum. We find as soon as we get below pH of 6.5 we lose flat crush—as soon as we get on the acid side.

MR. ZINKIL: I'll go along with Fritz. When we lowered the pH, we evidently precipitated the lignins and hemicellulose and got a much browner sheet. It's a little rough to run on a machine, but doesn't act at all like the slow, highly alkaline stock. Foaming is the biggest problem.

MODERATOR KNACK: Do you have something to contribute to this subject, Norval?

NORVAL F. WILSON (Missisquoi Corp., Sheldon Springs, Vt.): Well, I'm not involved in straw operation now, but I think

you might say that when you add some alum, the stock becomes more wild on the cylinders, and that it can be corrected by using more wastepaper. I don't think you'll gain much flat crush by running alum in the machine.

MR. LATHROP: Mr. Chairman, I'd like to call attention to something I don't know how you'd go about doing at all. Generally the isoelectric point, which is dependent on the pH, is the point of minimum swelling of material. That is particularly true on leather, for example. I have had some experience, years ago, on leather. And, since the shrinkage and swelling of the sheet are probably related to stiffness, it might be possible to think about the relation of pH to swelling.

As I say, I don't know how you get about it, but that might have something to do with this thing. I would guess (and I'm interested in this remark of yours about antiaciding) from what I know about pentosans, that the tendency to get on the acid side would reduce the swelling of the material and, where it is isoelectric, I don't know. So that there may be something in the business of running these sheets on the alkali side.

Don't let any of us forget that we're dealing with a multitude of things; many of the things we don't know anything about at all; and we're trying to feel our way, industrially, through this thing.

So I just want to throw that out as something to think about.

MR. KNAPP: Referring to Mr. Lathrop's statement, when we were experimenting with this alkaline stock preparation on linerboard, there was an interesting observation made by one person that, with the caustic, you get a swelling of the fiber. We brought up the question of adding alum to that to eliminate the caustic effects on felts, and his theory was that the minute you put alum on those fibers, swollen with caustic, they would shrink right up again, even as much or more than before, and, by adding alum, the effect of the caustic was completely nullified.

I'm only repeating that as a statement that was made to me; I've never tried it.

MODERATOR KNACK: Thank you, Mr. Knapp.

MR. GRUNWALD: We seem to have tried everything. We have been doing cooking, changing the cook; we talk about refining, disk refining, or what have you. There is one thing open, I think, to put something in there. I just went over these old notes. Treating the sheet after it was made.

MR. LATHROP: Are you talking about treating the sheet after it comes off the machine?

MR. GRUNWALD: Yes—treating the sheet going through the corrugator.

MODERATOR KNACK: Well, gentlemen, we got down as far as the questions that were asked on quality, and theoretical questions that were asked concerning caustics and the chemistry of straw pulping, and I think we have consumed the time that was allotted for this meeting.

Now I want to take this opportunity to thank all of you for your interest, for the help that you have given us, and I hope that we'll be able to have another such discussion at some later date.

CHAIRMAN ARONOVSKY: We are going to have a brief committee meeting in which we are going to discuss our next year's program; those who would like to are welcome to stay.

Before Mal goes, I want to thank him on behalf of the committee for the splendid job he has done getting up this program. I think it's been a very good and fruitful program.

Committee Meeting

A meeting of the Agricultural Residues Committee of the Technical Association of the Pulp and Paper Industry convened in Parlor B of the Commodore Hotel, New York, N. Y., at 12:05 p.m., Thursday, Feb. 21, 1952, S. I. Aronovsky Northern Regional Laboratory, Peoria, Ill., presiding.

CHAIRMAN ARONOVSKY: As a result of our committee meeting Monday afternoon, Mr. Krancher, Mr. Burns, Mr. Zinkil, Mr. Eberhardt, and I met yesterday afternoon and discussed the TAPPI appropriation project for the coming year. We developed the following outline which I discussed with John Parsons of the TAPPI Research Appropriation Committee.

TITLE OF PROJECT—HIGH YIELD STRAW PULP FOR OPTIMUM CORRUGATING MEDIUM

Purpose of project: (1) to obtain a critical survey of straw pulping for high quality corrugating medium; (2) to develop high yield straw pulping methods.

Summary of results expected from project: (1) a summary of previous work on methods of pulping straw; (2) methods of obtaining the highest possible yields of straw pulp to provide high quality corrugating medium.

Need for results desired: The straw industry is not getting the best possible quality end product from available raw material.

Procedure: It is proposed that the project be conducted by the staff of The Institute of Paper Chemistry at their facilities at Appleton, Wis.

Estimated Time to Complete the Project: One year.

Estimated Cost of Project: $10,000.

Mr. Parsons thought that this project would be satisfactory and suggested that the outline be expanded by writing brief paragraphs under each heading. I also went over this project briefly with the business manager of The Institute of Paper Chemistry, and he gave us the estimate of about $10-000. Mr. Parsons suggested that we obtain from the Institute a brief outline of their proposed procedure and a breakdown of the estimated cost. We can expect action from the TAPPI Research Appropriation Committee in about a month after the proposal reaches Mr. Parson's hands.

Since Mr. Krancher could not be here at this time I shall take it upon myself to prepare the proposal to send to Mr. Parsons. However, I shall ask Mr. Krancher to communicate directly with The Institute of Paper Chemistry for the information required from them. In view of the fact that 14 members of our committee voted on Monday afternoon to go ahead with this proposed project, Mr. Parsons will not require any further demonstration of committee approval.

Are there any objections to our handling the matter in this way?

(Everybody was in apparent agreement with the proposal.)

We are now ready to discuss the site for our Fall meeting. Mr. Palm, what is your feeling and that of your associates in having our 1952 Fall meeting in Trenton?

MR. PALM: I had quite a chat with our principals after the meeting on Monday on this subject and they are very sympathetic to the idea of having a session in Trenton. However, they think that timing is important. We are going to have the mill practically ripped apart in the next month or two (we hope, provided machinery gets there in time), and we certainly won't be settled down by the time of the Fall meeting to have something that we can really show—something that you would be interested in seeing, so our thought is to defer the meeting at Trenton until the following Fall or any time after we get squared away.

I would say that we ought to be pretty well straightened around by the first of next year. We are changing our methods of handling pulp and we are rebuilding our paper machine. It is a fourdrinier machine, as you know. We are putting on a dual press, adding driers, rebuilding the wet end, and so on.

MR. LATHROP: I agree with Mr. Palm that it would be more intersting for this group to go to Trention when the newer developments have been put into operation.

CHAIRMAN ARONOVSKY: We shall take a "rain check" on the proposed meeting in Trenton and keep it in mind for the 1953 Fall meeting.

That leaves two other possiblities—that is, cities in which there is a strawboard mill and which have sufficient hotel housing capacity for outside groups of 60 to 80 people.

Mr. Zinkil: In discussing that idea with Mr. Paramore on the phone recently, I can state that we are in the same boat that Bill Palm is in. We are going to rebuild our machines and right now we have a beater all torn up. A lot of our equipment is not expected until July and it is therefore doubtful if we can get cleared away by November. However, Mr. Paramore said that we might talk it over after I get back to Quincy and determine definitely whether we could have a meeting there this November.

Mr. Little: I cannot give you a definite answer as to Sandusky as I do not know at this time whether we can be ready for November. As you know, we are also making a number of changes in our Sandusky mill.

Mr. Lathrop: In view of the suggestion that straw grading be one of the major topics at the next Fall meeting, it might be desirable to hold this meeting at the Northern Laboratory. We have sufficient hotel facilities in Peoria to accommodate your group and we have ample facilities at the Laboratory for the technical meetings.

Chairman Aronovsky: I was coming to that. I think we would all like to have meetings at the mills more often. I believe that the committee as well as the other people in the strawboard industry have enjoyed the technical meetings at the mill. They have particularly enjoyed going through the mills and discussing with the operators their particular conditions and problems. They have had relaxing and good times at the mill meetings. There is an indefinable something about discussing strawboard mill problems in a mill, that is not there when the same problems are discussed at a place remote from the actual operations. Many of our people have expressed this feeling.

However, our meetings at the Northern Laboratory have also been well attended and successful. There we have a theoretical and research atmosphere as the background. Both of these types of meeting are desirable and I hope that we can continue to alternate between the Laboratory and the various mill sites as locations for our Fall meetings.

Under the circumstances, therefore, we shall plan to hold our 1952 Fall meeting at the Northern Laboratory in Peoria. People in this group have suggested that it is time that the strawboard industry get together on specifications for straw. These specifications are to include not only information on the collection and baling of straw but also on the types of straw desirable and on the grading of such straw for pulp production.

The suggestions were made that we hold a round-table discussion on this subject. I propose to prepare for this coming discussion in the same manner that Mr. Knack has gone about developing this meeting's program on straw pulping and processing. I shall write to the members of our committee and to the straw buyers, requesting questions for discussion on straw specifications and grading.

We shall also continue the remainder of the discussions on straw pulping and processing which could not be completed today due to lack of time and, of course, we shall have our regular committee meeting at this Fall session.

Is this type of meeting satisfactory to all of you? (There was complete agreement.) Is there anything else that needs to be discussed now?

I wish to announce that several people have left our committee, some at their own request, and I have dropped others because they did not come to meetings or show any particular interest in our program or work. We do not want to have "dead wood" on this committee because we all want to get something done.

Unless some of you have anything specific to bring up at this time, we shall adjourn. Before doing so, I wish to thank you all for coming to our meeting and for joining freely in these discussions. I hope to see you at Peoria next Fall.

The meeting of the committee adjourned at 12:20 p.m.

ATTENDANCE

Aronovsky, S. I., Northern Regional Research Laboratory
Bixler, A. L. M., Riegel Paper Corp.
Bowlan, Raymond J., Oliver United Filters, Inc.
Brown, H. H., Consultant
Brown, J., Sutherland Refiner Corp.
Burchfield, Paul E., Wyandotte Chemicals Corp.
Cameron, D. A., Alliance Paper Mills, Ltd.
Carpenter, N. Harry, Muskingum Fiber Products Co.
Cassiday, W. L., Alton Box Board Co.
Clark, J. d'A., Consultant
Eberhardt, Lee, Bauer Brothers Co.
Griffith, Arthur, Douglas Robbins & Co.
Grosse, K. M., Mutual Security Agency
Grunwald, F., Consolidated Paper Co.
Hale, B. F., C. T. Main, Inc.
Infanger, Arthur, The Cowles Co.
Kirchen, Charles P., Buckman Laboratories, Inc.
Knack, M. F., River Raisin Paper Co.
Knapp, E. O., Weston Paper & Manufacturing Co.
Lake, Leo, Kalamazoo Vegetable Parchment Co.
Lathrop, E. C., Northern Regional Research Laboratory
Little, J. R., Hinde & Dauch Paper Co.
Martin, H. C., Brown Paper Mill Co.
McNelly, D. P., Ft. Wayne Corrugated Paper Co.
Meyer, Horton A., The Cowles Co.
Montmorency, W. de, Pulp and Paper Research Institute of Canada
New, Paul G., General Chemical Div.
Palm, William H., Hinde & Dauch Paper Co. of Canada, Ltd.
Pinckney, J. E., Union Bag and Paper Corp.
Robbins, Douglas, Douglas Robbins & Co.
Springer, R. A., Diamond Alkali Co.
Staege, S. A., Black-Clawson Co.
Sutherland, D. Manson, Sutherland Refiner Corp.
Sutherland, L., Sutherland Refiner Corp.
Teyral, A. E., Diamond Alkali Co.
Wells, Evon Philip, Pioneer Chemical Co.
Wells, R. A., United Kingdom Scientific Mission
Westdale, Virgil W., Burroughs Adding Machine Co.
Wilson, N. F., Missisquoi Corp.
Zinkil, G. A., Central Fibre Products Co.

One of the Men Behind Eastwood Wires

Thomas Barrada

WEAVING A FOURDRINIER WIRE

Journeyman weaver Thomas Barrada tends a 230-inch loom, set up in 75 mesh; that means there are 17,250 warp wires between the mechanical "finger" in the foreground and the end of the loom. Back and forth across these wires flies a bobbin carrying shute, or filler, wire. Each time it traverses the width of the loom another shute wire is added to the woven wire cloth.

About 72,000 shute wires must be woven into the warp wires to make one fourdrinier wire a hundred feet long. From the first to the last, our skilled weavers watch over every wire to make sure that the paper manufacturer will get a top-quality fourdrinier wire cloth.

EASTWOOD-NEALLEY CORPORATION • Belleville, N. J.

Bursting Strength of Paper*

Proposed Revision af TAPPI Official Standard T 403 m-47

THIS STANDARD IS UNDER THE JURISDICTION OF THE PAPER TESTING COMMITTEE

For the purpose of this method, bursting strength is defined as the hydrostatic pressure in pounds per square inch (p.s.i.) required to produce rupture of the material when the pressure is applied at a controlled increasing rate, as described under Procedure, through a rubber diaphragm to a circular area, 1.20 in. in diameter, of the material under test, the test area being initially flat and held rigidly at the circumference but free to bulge under the increasing pressure during the test.

SCOPE

The method is designed to measure the bursting strength of paper and paper products having a bursting strength of not over 250 p.s.i. and in the form of flat sheets not over 0.025 in. thick. The method is not intended for use in testing corrugated boxboard, nor should it be used for hard boards that tend to cut the thin rubber diaphragm.

APPARATUS

The instrument shall have:

1. Means for firmly and uniformly clamping the test specimen, without visible slippage during the test, between two annular, plane, parallel, hard metal surfaces, stainless steel preferred. Since clamping surfaces are often subject to considerable wear and abrasion, they should be examined periodically and repaired or replaced when necessary.

The upper clamping surface (the clamping ring) shall have a circular opening 1.200 ± 0.001 in. in diameter. The surface which is in contact with the paper during testing shall have a continuous spiral 60° V-groove, countersunk 0.01 in. and of $^1/_{32}$-in. pitch, the groove starting at $^1/_8$ in. from the edge of the opening. The circular edge of the opening which is in contact with the paper during testing shall be merely relieved of sharpness, by means of a very fine abrasive cloth (such as crocus cloth) but not rounded off enough to alter effectively the diameter of the opening.

The lower clamping surface (the diaphragm plate) shall have a thickness of 0.125 in. and an opening 1.302 ± 0.003 in. in diameter. Its surface shall have a series of concentric 60° V-grooves countersunk 0.01 in. and separated by $^1/_{32}$ in., the center of the first groove being $^1/_8$ in. from the edge of the opening. The thickness of the plate *at the opening* shall be 0.025 in. The lower edge which is in contact with the rubber diaphragm shall be rounded by means of an arc of 0.25 in. radius, and shall be relieved of sharpness sufficiently to prevent cutting of the diaphragm when pressure is applied.

The clamping ring shall be connected to a clamping mechanism through a swivel-type joint or other suitable means to insure an even clamping pressure. During tests, the circular edges of the opening in the two clamping plates shall be concentric to within 0.01 in.

2. A diaphragm of pure gum rubber, 0.034 ± 0.002 in. thick, clamped between the lower clamping plate and the rest of the apparatus, so that, before the diaphragm is stretched by pressure underneath it, the center of its upper surface is below the plane of the clamping surface. The pressure required to raise the free surface of the diaphragm $^3/_8$ in. above the top surface of the lower plate shall be between 5.0 and 6.5 p.s.i. In testing this, a bridge gage may be used, the test being carried out with the clamping ring removed. The diaphragm shall be inspected frequently for permanent distortion and shall have been renewed less than 1 month prior to the test.

3. Means of applying controlled, increasing hydraulic pressure to the underside of the diaphragm until the specimen bursts. This pressure shall be generated by a motor-driven piston forcing ethylene glycol containing a suitable corrosion inhibitor (high-grade "permanent" radiator ethylene glycol antifreeze may be used) in the pressure chamber of the apparatus at the rate of 95 ± 5 ml. per min. The hydraulic system, including the gages, shall be mounted so as to be free from externally induced vibrations.

Note: Since the bursting resistance of paper increases with increased rate of loading, the rate of strain must be maintained effectively constant to obtain reproducible results. Air present in the hydraulic system of the tester will lower the rate of distortion of the sample, and must be substantially removed. Air is most commonly trapped under the rubber diaphragm and in the tubes of the gages. A simple method of testing for the presence of allowable quantities of air is given in a later section.

4. A maximum-reading pressure gage of the twin-needle bourdon type, of appropriate capacity and having a graduated circular scale $3^3/_4$ in. or more in diameter shall be used. The choice and characteristics of the gage shall be as set forth in Table I.

* This revised method has been approved as a Tentative Standard by the Standards Committee. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

Table I. Gages

Range of bursting pressure, p. s. i.	*Range of gage, p.s.i.*	*Scale graduation intervals, p.s.i.*	*Expansibility of gage, ml./p.s.i.*
5–25	0–30	0.2	0.011
25–110	0–120	0.5	0.004
110–250	0–300	1.0	0.001

Notes: (1) The 0–120 range gage may be used for any test within its capacity, if so noted in the report.

(2) The expansibility of a gage is defined as the volume of liquid entering the gage tube per unit increase in pressure, when air is absent. It can be determined most conveniently by means of a dilatometer device described in reference 6. The gage expansibility shall lie within 15% of the specified value.

(3) An appreciable flow of liquid into the gage occurs from the start of the test to the instant of burst. The gage therefore reduces the rate of distension of the sample by an amount depending upon the expansibility of the gage. When a number of gages are mounted on a single apparatus, care must be taken that only the gage on which the measurement is being made is open to the hydraulic system, as otherwise erroneously low burst pressures will be recorded.

(4) To avoid overloading and possible damage to the gage, a preliminary bursting test should be made with a high-capacity gage.

CALIBRATION OF GAGE

For ordinary purposes the gage shall be calibrated, while inclined at the same angle at which it is used, by means of a deadweight tester of the piston type, or by means of a column of mercury. Such calibration is preferably carried out with the gage in its normal position in the instrument.

When a precision of better than 3% is sought, the gage shall be calibrated by applying known pressures dynamically to the gage at substantially the same rates as in the testing of paper.

Note: Maximum-reading pressure gages are subject to dynamic errors in addition to the ordinary static calibration errors. A suitable method of dynamic calibration is described in reference 5. For rough checking purposes, bursting tests on aluminum foil may be used. Standardized foils for this purpose, bursting over the range 15 to 150 p.s.i., may be obtained from the Pulp and Paper Research Institute of Canada, 3420 University St., Montreal, Canada. An alternative procedure is to carry out comparison bursts with a standardized gage.

Gages in frequent use should be calibrated at least once a month. If a gage is accidentally used beyond its capacity, it shall be recalibrated before it is used again.

CHECKING FOR AIR IN SYSTEM

The instrument shall be checked as follows when first assembled or subsequent to changing gage or diaphragms or adding liquid. Fill the opening from the rubber diaphragm to the level of the clamping surface with water and clamp a rigid metal plate, with a sheet of thin rubber to prevent leakage, in the position normally occupied by the sample. Turn the shaft of the pump by hand until a pressure is just registered on the gage. Then turn the shaft so that 0.4 ml. of fluid is displaced. (In the Mullen tester where a pump shaft rotates at 115 r.p.m., a displacement of 0.4 ml. corresponds to a half turn (180°) of the shaft.) Observe the pressure developed. Pressures less than the following indicate the presence of excessive quantities of air in the system or erroneous gage expansibilities:

Gage range	*Pressure developed, p.s.i.*
0–30	12
0–120	35
0–300	90

A gradual loss in the pressure obtained indicates a leak in the system which should be corrected.

TEST SPECIMEN

The test specimens shall be at least 2.5 by 2.5 in., and shall be representative of a sample obtained according to TAPPI Standard T 400 m. They shall be conditioned and tested in an atmosphere in accordance with TAPPI Standard T 402 m.

PROCEDURE

Clamp the specimen securely in position, apply the hydrostatic pressure as specified in item 3 under Apparatus until the specimen ruptures, and record the maximum registered by the pressure gage. Watch carefully for movement of the unclamped margin of the specimen. If slippage is indicated, discard the test and increase the clamping pressure for subsequent tests. Make at least ten tests, using as many of the sheets comprising the test specimens as possible, and applying an equal number to each side of the paper.

Make no tests on areas containing watermarks, creases, imperfections, or visible damage. After each test return the indicator needle of the gage *gently* to zero.

REPORT

The bursting strength shall be reported in pounds per square inch (p.s.i.) as the arithmetical mean of the test results, corrected for any gage error, to three significant figures. The report shall also include the number of tests and either the standard deviation or alternatively, the maximum and minimum values.

The term "points" is frequently used in place of p.s.i. in connection with bursting strength of paper and the results may be so reported if desired.

REPRODUCIBILITY OF RESULTS

Results of tests made on different samples from the same shipment, or on different instruments, are expected to agree within 5%, except possibly for tissues and other papers with a bursting strength of 10 p.s.i. or less.

ADDITIONAL INFORMATION

The principal changes in this revision as compared with the present method are:

1. The scope is increased from a maximum of 200 to a maximum of 250 p.s.i.

2. The following changes have been made in the instrument:

(a) On the lower surface of the clamping ring a continuous spiral 60° V-groove, countersunk 0.01 in., is specified instead of the present optional concentric tool marks not over 0.002 in. deep.

(b) The diameter of the opening in the diaphragm plate is increased from 1.25 to 1.302 in. to facilitate axial alignment of the upper and lower clamps. The inner edge of the plate is reduced to a thickness of 0.025 in., with a definite rounding of the lower edge specified.

(c) The quality of the rubber diaphragm is specified.

(d) Ethylene glycol containing a corrosion inhibitor is specified for the hydraulic liquid.

(e) Twin-needle bourdon-type gages with a larger diameter are specified, and a wider range is allowed.

3. A means of checking for air in the system is added.

In view of lack of complete agreement in regard to some of the above changes, the method has been reverted from an Official to a Tentative Standard.

REFERENCES

1. Carson, F. T., and Worthington, F. V., "A Critical Study of the Bursting Strength Test for Paper," *Bur. Standards J. Research* 6: 339, *Research Paper* RP 278 (1931).
2. Carson, F. T., "Some Notes on the Revision of Methods for Measuring the Strength of Paper," *Paper Trade J.* 102: TS 253 (1936).
3. Clark, James d'A., "Determining the Bursting Strength of Paper," *Technical Assoc. Papers* 4: 367–370 (1932).
4. Oliver, C. V., "Variability in Results Met With in Paper Strength Testing," *Proc. Tech. Sec. P.M.A.* 11, Part 1: 53 (1930).
5. Tuck, N. G. M., Faichney, L. M., and Mason, S. G., "The Dynamic Calibration of Maximum-Reading Pressure Gages" (to be published).
6. Tuck, N. G. M., and Mason, S. G., "Some Factors Influencing the Accuracy of the Mullen Tester," *Pulp and Paper Mag. Canada* 50, No. 11: 132 (Convention Issue, 1949).
7. Underbay, C. F., "Bursting Tester Standardization," *Proc. Tech. Sect. P.M.A.* 11, Part 2: 247 (1931).

Specific External Surface of Pulp*

Proposed Revision of TAPPI Suggested Method T 226 sm-46

THIS SUGGESTED METHOD IS UNDER THE JURISDICTION OF THE PULP TESTING COMMITTEE

This method is suitable for determining the specific surface of chemical pulps, groundwood, wood flour, and similar materials.

The specific surface is defined as the exposed area in square centimeters per gram of moisture-free sample and provides a measure of the degree of fineness or fibrillation.

APPARATUS

1. *Reaction Apparatus* as shown in Fig. 1. The reaction vessel *A* is made from a 500-ml. wide-mouthed Erlenmeyer flask. Two indentations, *C*, are made in opposite sides near the bottom to direct the swirling liquid downward. A glass tube, *D*, is inserted tangentially near the bottom at an angle of about 45° to hold a thermometer, *E*, (0 to 50°C., graduated to permit estimation to 0.1°C.) in position, so that its bulb is immersed during the reaction. A tight rubber washer, *F*, on the stem of the thermometer prevents the bulb from touching the bottom, which would thus trap and hold the fibers.

A small vertical motor and chuck, *G*, is mounted to rotate the glass propeller shaft at 600 r.p.m. The shaft carries a two-bladed glass propeller, *B*, 4 cm. in diameter, with blades set at an angle. It is important that the direction of rotation of the propeller be such as to cause a downward deflection of the liquid as it flows past the indentation in the reaction flask

Also included are two burets of 25 ml. capacity, preferably with bell mouths for easy filling, one with an extension to the delivery tip; a removable support (*J*) for the flask; and a funnel (*H*) having a capacity of 30 ml. or more, with a large-bore stopcock so that the contained liquid can be delivered quickly.

All this equipment is mounted on a heavy stand by means of suitable clamps, the burets preferably being held by spring clamps so that they may be easily moved up and down or removed.

2. *Hot Plates.* Two of 1200-watt capacity, three-heat. One is set at "medium" for silvering fibers, and is covered with a sheet of asbestos paper. A motor-driven, small glass propeller is mounted above the plate. The propeller is adjusted to approximately 300 r.p.m. The second hot plate is set at "high" for the initial heating.

3. *Crucibles.* Jena IGI or Pyrex fritted-glass crucibles, of coarse porosity.

4. *Porcelain Casserole*, of approximately 200 ml. capacity.

5. *Stopwatch or Stopclock*, preferably 100 sec. per revolution.

6. *Dissecting Needle*, of platinum or iridium.

REAGENTS

Caution: As this method is based on a catalytic reaction, scrupulous cleanliness is essential, and distilled water of unquestionable purity must be used for preparation of all reagents and of the pulp suspension. The ordinary laboratory distilled water has been found unsuitable in many instances. Impurities in the distilled water are evidenced in formation of a debris on heating the diluted silvering solution in the absence of fibers (a blank test), and in excessive clumping of fibers during silvering. If redistillation is required, add a small quantity of $KMnO_4$ to the water in the glass distilling flask before distillation is begun.

Precautions should be taken that none of the permanganate is carried over in the spray by using a distilling column or a flask with a long neck in which a loose plug of glass wood is inserted.

A. *Silvering Solution.* Dissolve 200 grams of C.P. silver nitrate ($AgNO_3$) in 1500 ml. of water. Add, with stirring, 160 ml. of conc. NH_4OH. Then slowly add dilute NH_4OH (1:10) until the brown precipitate first formed *just disappears, avoiding addition of an excess.* If the silvering solution is too alkaline (i.e., perfectly clear), very troublesome debris will be formed during the silvering, so that any excess ammonia should be neutralized by adding a little more $AgNO_3$ solution until a

* This method is suggested by the Standards Committee as being the most suitable to date. It is *not*, however, a TAPPI Standard. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York 17, N. Y.

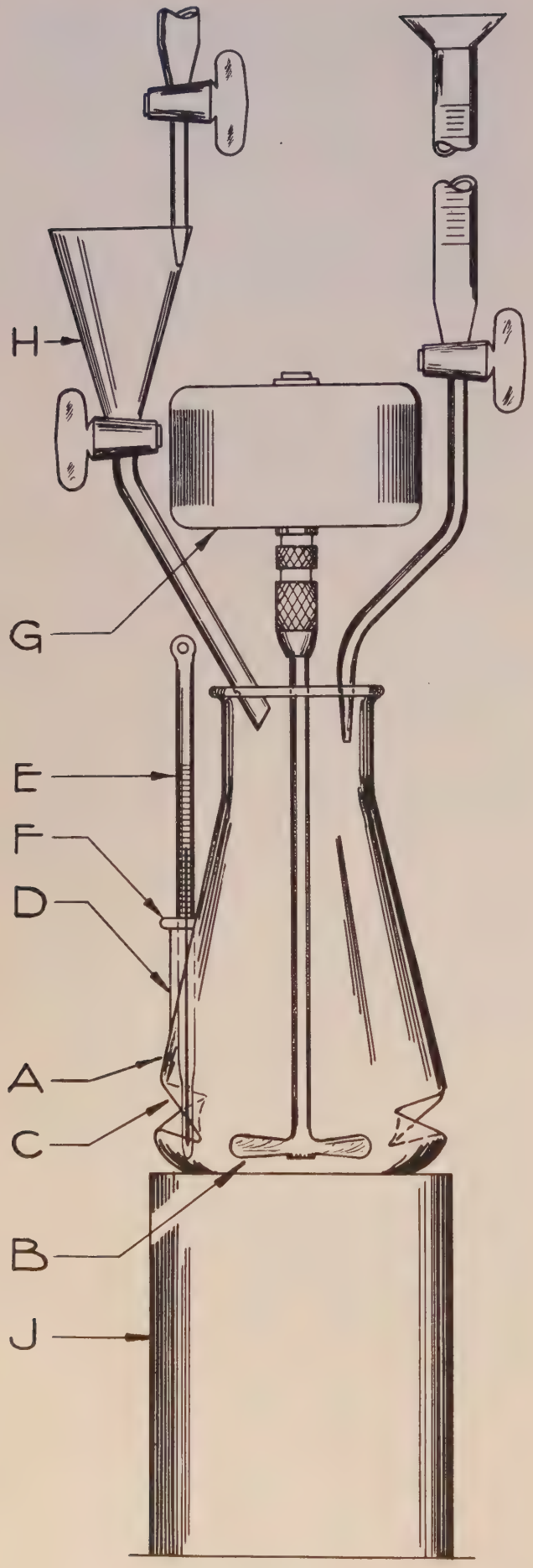

Fig. 1. Reaction apparatus

very faint cloudiness is visible. It is very important to prepare the solution correctly.

Dilute with water to 2 liters and store in a dark glass-stoppered bottle. This solution may be kept for periods up to 1 month. (*See* Note 6.)

B. *Potassium Permanganate*, 0.5 *N*. Weigh out 31.6 grams of C.P. $KMnO_4$ and dissolve in about 1.5 liters of water. Heat the solution at slightly below the boiling point for about an hour, filter through glass wood or asbestos, and dilute to 2 liters. This solution need not be accurately standardized.

C. *Hydrogen Peroxide*, 0.5 *N*. Measure 25 ml. of 30% H_2O_2 solution into about 750 ml. of water containing 4 ml. of *N* H_2SO_4. Dilute to approximately 1 liter. Adjust the concentration so that 24.5 to 25.0 ml. of H_2O_2 solution is equivalent to 25.0 ml. of $KMnO_4$ solution. This adjustment must be made daily.

D. *Sulphuric Acid*, approx. 2 *N*. Dilute 53 ml. of conc. H_2SO_4 to 1 liter.

E. *Sodium Borate Buffer Solution.* Weigh out 25 grams of C.P. sodium borate ($Na_2B_4O_7 . 10H_2O$), add it to 400 ml. of warm water containing 20 ml. of *N* NaOH solution and dilute to 500 ml. Dilute 100 ml. of this solution to 2 liters.

F. *Asbestos.* Ordinary acid-washed asbestos of Gooch crucible grade made into a slurry with water to a consistency suitable for Gooch crucible preparation (approximately 3 grams of asbestos per 100 ml.).

TEST SPECIMEN

If the pulp is air-dry, weigh out a representative portion of approximately one gram and completely defiber in water with a minimum amount of agitation and stirring. It is recommended that the weighed sample be soaked for an hour or more, and then defibered by stirring as gently as possible. If the sample is received in slush form, the preliminary defibering is unnecessary.

Filter the suspension prepared from air-dry pulp, or an amount of slush pulp equivalent to approximately one gram of moisture-free material, through a coarse-porosity, fritted-glass crucible (do not apply suction until a mat is formed), and wash thoroughly with water. Remove the pulp pad from the crucible with the dissecting needle and place it in a 4-liter beaker. Add enough water to give a consistency such that a volume of 110 to 140 ml. will require 3 to 8 ml. of $KMnO_4$ solution in the back titration. The proper consistency must be determined by making a preliminary specific surface determination by the procedure outlined below. Usually the volume will be 2 to 3 liters at this point. The following table may be used as a guide in estimating the approximate dilution of the pulp suspension.

	Approximate area, sq. cm. per gram	*Desired consistency, grams of moisture-free pulp per liter*
Unbeaten pulp	7,000– 15,000	0.15–0.25
Groundwood	15,000– 25,000	0.12–0.15
Beaten pulp	10,000– 50,000	0.10–0.20
Headbox stock	20,000–100,000	0.03–0.10

PROCEDURE

Caution: Special care should be used in cleaning the reaction

vessel, propeller, and thermometer after each test, as the presence of a single drop of the end product of the previous reaction will cause a substantial reduction in the succeeding test.

Using the porcelain casserole, vigorously agitate the suspension, then quickly remove a portion of not less than 110 nor more than 140 ml. by dipping the casserole to the bottom of the beaker and lifting it out. Transfer the entire portion to a graduate and record the volume to the nearest milliliter. Pour the sample into a 250-ml. beaker, rinsing the graduate with a few milliliters of water. Heat to boiling by placing the beaker on the hot plate set at "high." When the liquid is boiling, place the beaker on the second hot plate set at "medium." Introduce the stirrer and start the motor rotating to about 300 r.p.m. Add 15 ml. of silvering solution from a 25-ml. graduated cylinder. The temperature of the solution during the silvering operation should be close to 100°C. Record the time at the addition of the silvering solution. (*See* Note 7.)

After a total silvering period equivalent to three times that from the addition of silvering solution to the change in color of the fibers from reddish-brown to black, remove the beaker from the hot plate, add about 10 ml. of asbestos suspension, mix by swirling, and filter immediately on a Gooch crucible containing a 1/8-in. asbestos mat. Rinse the beaker with water to transfer the silvered fibers to the crucible. Add to the crucible an additional 10 ml. of asbestos suspension to form a mat on the fibers. Wash thoroughly with water, taking care to wash all soluble silver salts from the inside wall of the crucible.

When the washing is complete, remove the mat together with all silvered fibers to the reaction flask with the dissecting needle. Wipe out any fibers adhering to the crucible with a small quantity of moist asbestos on the needle. Attach the flask to the stand and add 100 ml. of the diluted buffer solution. Run into the special funnel a volume of 0.5 *N* H_2O_2 equivalent to 25.0 ml. of 0.5 *N* $KMnO_4$. Turn on the stirrer, which has been adjusted to rotate at 600 r.p.m., and stir for 15 to 20

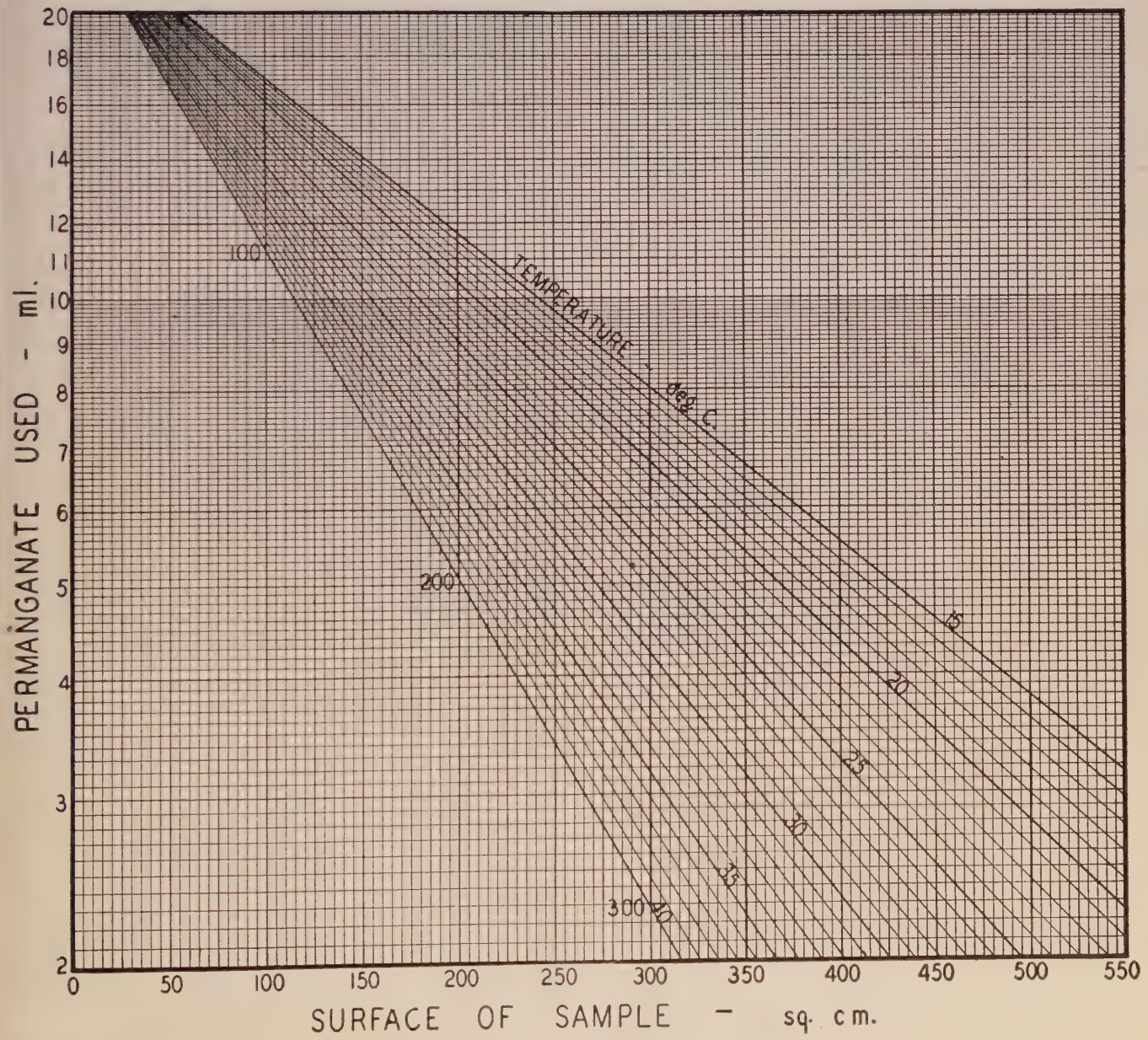

Fig. 2. Calibration chart for specific surface

sec. to break up the pad. Open the funnel stopcock and start the timer at the moment the peroxide enters the solution. Rinse the funnel with 2 to 3 ml. of water. At the end of 20 sec., record the temperature and remove the thermometer to prevent accumulation of fibers against it. Close the funnel stopcock and place 15 ml. of 2 N H_2SO_4 in the funnel.

At the end of exactly 100 sec., run the acid from the funnel into the reaction flask and rinse the funnel with water. Titrate the remaining undecomposed H_2O_2 with $KMnO_4$ solution. From the amount of $KMnO_4$ used, determine the surface area, A, of the sample from the calibration chart (Fig. 2).

If the consistency of the suspension is either too low or too high, as indicated by the permanganate titration, it must be adjusted and the above procedure repeated until the desired consistency is obtained.

The consistency is determined by filtering off the fibers contained in about 500 ml. of suspension on a weighed Gooch crucible with an asbestos mat, drying overnight or to constant weight at 100 to 105°C., and weighing. Measure the consistency sample with the same care used in measuring the test specimen. Thoroughly stir the pulp suspension, dip out portions with the casserole, and transfer the whole of each portion to a 500-ml. graduated cylinder. Record the exact volume, which should be less than 500 ml. (*See* Note 8.) Divide the weight of dry fibers in grams by the total volume of suspension in milliliters, and multiply by 1000 to obtain the consistency in grams per liter. Run duplicate determinations and take the average.

REPORT

Calculate the specific surface from the formula:

$$S = \frac{1000A}{CD}$$

where

S = specific surface in sq. cm. per gram of moisture-free pulp
A = surface area in sq. cm.
C = consistency of pulp suspension in grams per liter
D = ml. of pulp suspension tested

Run at least three determinations and report the average. The maximum deviation should not exceed ±5% of the average.

Notes: (1) In order to facilitate cleaning the flask later, because MnO_2 is absorbed by the glass surface and constitutes a potent catalytic inhibitor, it is advisable to run a few extra milliliters of H_2O_2 after equivalence has been reached and later to tip and rotate the flask, so as to bathe the sides of the flask with the excess peroxide.

(2) Between determinations, the reaction flask, propeller, funnel, and thermometer should be rinsed thoroughly with distilled water. To remove deposited material from the reaction flask, treat with hot dil. HNO_3 (1:1).

(3) When the H_2O_2 buret does not drain cleanly, it is necessary to treat it with 50% NaOH solution, afterward washing it thoroughly with distilled water.

(4) The silvering beakers and propeller should be washed after each test with HNO_3 (1:1) to remove deposited silver.

(5) The time required for silvering depends upon the nature of the pulp, and may vary from 5 to 60 min. In case of doubt, or in testing a pulp of unusual character, it is recommended that several samples be run at different silvering times. The results obtained when silvering is continued beyond a certain minimum time will be found essentially identical. Microscopic examination of a few fibers removed from the suspension with a dissecting needle will be found helpful in judging the course of silvering. All elements of the fibers should appear black or very dark orange. The time of silvering, beyond the minimum necessary to completely cover the fibers with a black coating of silver, is not critical. Excessive silvering times result in a slow increase in area, caused by actual changes in dimensions of the silvered fibers, and should be avoided; also, the fibers may become brittle and break into fine fragments during the stirring.

(6) The silvering solution should form no debris and the silvering beaker should show only a smoky haze upon dilution of 15 ml. of the solution with water and heating for approximately 15 min. as in the actual silvering of fibers. If the silvering solution has been properly prepared otherwise and a troublesome debris still forms during a blank test, it may be found helpful to reflux the stock solution before use. Boil gently for 2 hours under a water-cooled reflux condenser, cool, and filter through a plug of glass wool inserted in the cone of a filtering funnel.

(7) Although the effect of light has not been established, it is desirable to avoid exposure of the solution to strong light during the silvering procedure; otherwise some debris of reduced silver may be formed.

(8) To obtain an accurate consistency of the pulp suspension it is advisable not to try to adjust the volume measured to a predetermined value, since the pulp is usually dewatered when only a portion of the suspension is poured out of a container.

ADDITIONAL INFORMATION

A wide latitude in the choice of equipment, procedure, time of reaction, and strength of reacting solutions appears possible if the same conditions are followed when the calibration chart is prepared, but the adopted conditions should be meticulously followed once they have been established.

A nomograph alignment chart somewhat simpler than Fig. 2 has been published by D. S. Davis in *Paper Industry and Paper World* 25, No. 10: 1109 (Jan., 1944) and will be found convenient where a considerable number of determinations are run.

REFERENCES

Clark, James d'A., *Paper Trade J.* 115, No. 1: 32–39 (July 2, 1942); *Tech. Assoc. Papers* 25: 568–575 (1942).
Browning, B. L., and Baker, P. S., *Tappi* 33, No. 2: 99–100 (Feb., 1950).

Pulp and Paper Mill Lubricants Specifications

A. I. SIPPOLA

The question of lubricant specifications, and perhaps more important, the procurement of lubricants by specifications, has been considered and, to some degree, practiced by a number of purchasers. Those who have set up specifications covering their immediate requirements have, in most cases, been equipped with laboratory facilities, personnel, and technicians, which would enable them to run standardized physical tests on lubricants and have had lubrication requirements that can be met with commodity products under the control of experienced personnel.

More important to the actual running of these tests is the interpretation of the results and their evaluation in terms of expected performance characteristics. In short, it must be said at the outset that there are certain recognized tests for lubricating oils and greases, but their interpretations and limitations must be clearly understood in order that they be of any value.

As the operators of paper mill machinery, your main concern is to assure operation without lubrication failures, thus securing (1) maximum production with minimum machine outage, (2) reduced maintenance costs, and (3) minimum lubrication costs.

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How can oil and grease specifications be associated with performance of the lubricant in a machine. There is only one true evaluation of lubrication success, and that is through observation and evaluation of the results obtained in production machinery, and not in the laboratory.

Perhaps a few words relative to the thoughts and findings of the American Society for Testing Materials regarding oil and grease specifications are in order. It will be realized that the ASTM, through their various committees, have devoted much time, effort, and energy to arrive at suitable oil and grease tests which could be recognized, at least to a degree, for evaluating the anticipated performance of lubricants.

T. A. Boyd of the General Motors Corp. Research Department, who was President of the ASTM several years ago, reviewed the findings[1] of a special subcommittee of Committee D-2 on Oil Purchases and Specifications. His opening remarks introducing a symposium on oil procurement practices were as follows:

> There is not nearly enough reliable information now available as regards test methods to permit writing workable oil-purchase specifications which would within themselves, without performance tests, serve as a reliable guide in the selection of lubricants. Many years of intensive work on an extensive scale have been spent developing oil-test methods, and such work is now actively in progress. But the present status of the work and the outlook for some years in the future indicate an inadequacy of the test methods to meet the minimum requirements for preparing satisfactory oil-purchase specifications.
>
> There are three most important characteristics of a lubricant:
>
> 1. Proper viscosity at the operating temperature and pressure, where lubrication is in the fluid film region.
> 2. "Oiliness" where lubrication is in the boundary film region.
> 3. Oxidation and thermal stability.
>
> Satisfactory laboratory test methods for measurement of viscosity at atmospheric pressure are available. Those for measurement under high pressure and high rates of shear are less satisfactory. There are no acceptable methods for the measurement of "oiliness."
>
> Many tests have been developed and used for the measurement of oxidation stability. None have been found to be generally satisfactory, although some have been applied to a limited extent in testing lubricants for specific uses.
>
> Until the above and other laboratory tests can be correlated with service requirements it will be necessary to continue to rely upon performance tests to supplement the laboratory tests.

Up to the present time there are some 130 ASTM tests for petroleum products. But these tests have permitted establishing ASTM specifications for only the following five types of petroleum products: motor gasoline, diesel fuels, fuel oils, aviation gasoline, and Stoddard solvent.

Of these ASTM tests, only about one half are applicable to lubricants. None of these, however, can be used to completely predict the performance of lubricants under a variety of operating conditions.

It may well be asked, of what value are these tests if they cannot be used to predict performance? Before a reputable refiner offers a new product for general use, it will have performed to his satisfaction in many field tests. To make sure that the refinery in its regular production makes a lubricant that is consistently equal to the product tested in the field, certain controls and checks must be available. The petroleum tests referred to are of great value to the refiner for this purpose.

Let us consider the basic specifications which might be utilized for the procurement of lubricants. According to B. C. Voshell (ASTM "Symposium on Procurement of Lubricants") there are two interpretations that might be placed on the phrase "purchase specifications" as applied to lubricants Such specifications might

1. Prescribe the methods of refining and manufacture along with the formulation of the lubricant—in other words, "composition specifications."
2. State the physical and chemical properties capable of being measured in any laboratory by standard methods of test on small samples—which we might call "physical specifications."

In considering the above two interpretations, except in the case of some commodity lubricants, it is improbable that a manufacturer of pulp or paper could draw a specification which completely defines the lubricant required under the category noted as "composition specifications." Added to this is the fact that differences in refining methods produce a variance in end products, all of which may have a definite influence on final performance characteristics.

The interpretation designated "physical specifications" is a "statement of physical and chemical properties capable of being measured in a laboratory by standardized methods of test on small samples of the oil." If the purchaser has established certain processes or procedures in his plant, the uniformity or continuity of which depends on the lubricating oil, then he is right in making certain that his oil supplier does not vary the quality or characteristic of its product. If this is the case, the purchaser can then do one of several things.

He can secure lubricants from a supplier who warrants uniformity and then trust that warranty. The reputation of the supplier and the buyer's own experience with suppliers are then his best guide.

He can secure from the supplier the control tests which the supplier uses in his own laboratory for his own use, provided, of course, he has available the equipment and technical "know-how."

He can establish tests of his own and demand that the supplier's deliveries always meet them. Since, for the greater part, such tests will, in reality, be one or more of those included among the standardized petroleum tests, it is quite likely that the supplier already submits his product to such test work. There are exceptions to this, however, under cases of extremely critical requirements of certain types.

Accordingly, the use of physical specifications is reasonable and possible within certain limits as long as the purchaser uses specifications as a check against the uniformity of products delivered. It cannot be stated generally that such specifications will guarantee a product which will meet the performance results desired.

It was pointed out that there is not really enough reliable information now available as regards test methods to permit workable oil-purchase specifications which would, within themselves, and without performance tests, serve as a reliable guide in the selection of lubricants.

Accordingly, it would seem that any specifications set up would fall under the category of "physical specifications" and they, in themselves, might be entirely inadequate to predict performance characteristics in the machine. In addition, lubricants provided against such specifications do not carry the responsibility and service of the supplier, and for this reason there is no assurance that the best available product for the job will be secured. Accordingly, the next best choice is the purchase of lubricants on a brand-name basis. It is important, however, that these names represent truly individual brands signifying a product or products which have been specifically proved for a given service.

The machinery involved in any paper mill represents a substantial investment. In order that a return on this investment be realized, it is essential that the machinery be operated with no interruptions in production and with minimum maintenance expense. The cost of lubricants, which must facilitate operation without the above losses, represents a small portion of the capital, maintenance, and operating expenses.

Lubricant costs for paper and pulp mills will vary from $1000 to $15,000 per year depending on the extent of the operation and the efficiency of lubrication control. This cost in terms of paper produced will vary from several cents to about $0.35 per ton. The average is about $0.10 to $0.20 per ton. This cost represents a small fraction of the total cost of producing paper.

[1] "Symposium on Oil Procurement Practices," published in booklet form by the American Society for Testing Materials.

Let us consider the maintenance cost of a fairly large, fully integrated mill equipped with a combination of old and modern machines and auxilliaries. This may be approximately $200,000 per year. Since maintenance is, in part, directly influenced by lubrication, a saving of 10% which is not unusual through improved lubrication controls, would represent $20,000. For such a mill, the total lubricant cost may range from $10,000 to $20,000 per year. Thus, a 10% maintenance saving wipes out the oil and grease bill.

More important, however, is the saving realized by minimizing machine down time through reduced mechanical failures. Such savings can equal $500 per hour on high-rate production machines. Thus, the over-all effect of lubrication far outweighs any possible saving in lubricant cost which might be accomplished through competitive specification purchasing at a sacrifice of correct lubrication results.

It is the function of this lubricant to replace dry friction with fluid or plastic friction and, as such, must do the job under a variety of operating conditions. It is true that in many cases commodity lubricants, or those which have been purchased on a specification basis only, will adequately do the job. However, much of the paper mill equipment is operated under adverse conditions and for it the lubricants must have special characteristics that enable them to resist deterioration due to the operating influences.

In view of this, certain qualities must be built into lubricants to provide resistance against this variety of deteriorating influences. While it is possible to accomplish this, the lack of acceptable tests will not permit complete evaluation of the product in the laboratory. Evaluation can only be done through controlled testing in actual production machinery covering the many types of operations involved. Once a lubricant has been selected for a specific requirement after being screened through all methods available, and all performance records indicate satisfaction, it is then possible for the supplier to set up physical tests which would identify the material furnished if he continues to purchase from the same supplier. Control tests which identify a suitable lubricant from one supplier will not necessarily guarantee an equivalent product from another supplier who uses different crude oils and refining processes. Let's consider several critical paper mill lubricants in light of the possibility of procuring such lubricants through specifications.

One of the most critical services in this industry is perhaps represented by the antifriction drier bearings used on paper machines. The conditions presented by this service requirement, while being critical, take on added importance in that the failure of any single unit can result in lost production through machine outage—all representing a substantial expense.

The conditions of operation are severe in that a combination of high temperature, high humidity, and possible water contamination, along with contamination by paper fly are present. Because of these conditions, the capacity of such systems in comparison with others is very large, representing a substantial investment in lubricating oil and oil-handling equipment. The large capacity permits ample oil flow with proper recycling periods to minimize the oxidizing influence of high temperature and to permit sufficient resting time to separate moisture and other possible contamination.

To satisfy these conditions and to provide the anticipated long-term service without need of oil renewal, very special and specific properties must be built into the lubricant. These are accomplished through the use of various inhibitors which will provide protection against rust, resistance to oxidation at high temperatures, and possibly antiwear additives. To provide such a product it is necessary to carefully select the type of base stock to be employed and then to match with it the inhibitors that will be compatible with each other and provide all the advantages desired. In addition, the finished products should obviously not cause corrosion of bearings, nor any other elements of the system. In view of the extensive research required to arrive at the proper combination of materials, it would be extremely difficult for a purchaser to attempt to provide the proper specifications. Physical characteristics can, of course, be designated but the final product will be recognized as branded merchandise with the full backing of the petroleum supplier.

Another example might perhaps be well represented by the use of grease for specialized antifriction bearing lubrication in paper mills. Again the conditions presented are dust, dirt, heat, and water. The greases offered today, as in the case of oils, have become more complex in that they have been greatly improved through the use of different combinations of soaps and mineral oil, along with the desired types of inhibitors to protect against such things as corrosion, water washing, oxidation, etc.

A true evaluation of the product, as can very well be gathered from the above, would rest with its performance in its selected field of service.

The research facilities of the petroleum industry are one of the largest of any single group of industries. With these research facilities and "know-how" the oil industry is continuously searching for improvements in products. All these improvements are pointed toward improved performance characteristics in service. The petroleum industry is proud of the quality built into products which have been developed over the years, and which have kept step with improved machine design. Because of this, as in the case of the paper industry, and others, these products are branded. Such products are produced under controls established to secure maximum uniformity.

As a buyer of lubricants, the paper industry, as well as others, should consider lubricant procurement on the basis of purchasing lubrication and not oil or grease. When correctly recommended products are placed in service in mill equipment, the engineering "know-how" and service of the supplier go along with this product. In short, you are purchasing lubrication knowledge and engineering counsel to assist in the proper application of these products and the proper maintenance of the lubrication systems which are a part of the machines themselves.

If it is to be accepted that purchasing oils on a specification basis has its shortcomings, as previously covered, then what constitutes the best and proper approach to lubrication problems which are encountered in the pulp and paper industry? In most cases such problems can be worked out through the cooperative effort of the user, the petroleum supplier, and in many cases, with the machinery builder. This is essential since lubrication characteristics encompass not only the characteristics built into a lubricant, but the characteristics built into the machine elements. Answers to many of these problems have already been developed, and through the information at hand from previous experiences the problems usually can be solved quite readily. However, in light of the increasing critical nature of the requirements in the industry, such as higher speeds, higher temperatures, closer tolerances, etc., closer cooperation with a complete exchange of information between the three parties should advance ideas leading to possible corrective measures.

Under such conditions, the technical knowledge of the mill engineers, combined with the knowledge of the lubricant supplier and the designers of the machine, a wholly cooperative effort will assist in arriving at the basic requirements from which a selection of the proper type of lubricant can be made. It must be stressed, however, that at least a three-way effort is required here since the builder is better aware of design details, the user is fully aware of the factors presented by his operation, and the lubricants supplier should be able to translate the requirements in terms of petroleum characteristics in order that his research organization can then put together the correct formulation.

The success of lubricants recommended for specific requirements will depend to a great extent on the procedures of ap-

plication employed. To assure correct procedures, lubrication service and engineering counsel are available and are part and parcel of the purchase of branded lubricants. Even a correct lubricant can fail to perform if all other interconnected phases of application are not correctly exercised. Accordingly, the value of such service to the purchaser has been proved in every phase of the business. This is true of the petroleum industry as well as the pulp and paper industry, along with all others.

User satisfaction, therefore, can best be assured by relying on the integrity of the manufacturer, by looking to his brand as the hallmark of his integrity, by submitting his products to the acid test of performance, and by evaluating his service in terms of the results achieved—maximum production—minimum machine outage—minimum maintenance experience.

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Factors Affecting Chipper Knife Performance

HAROLD F. WOOD, JR.

There are two phases to chipper knife performance or, for that matter, the performance of any piece of equipment. One phase is the processes used to build the knives, which are the manufacturer's responsibility and the other is the correct usage of the knives, which is the consumer's responsibility. It is necessary, therefore, to review both phases so that both are open for discussion and comment.

The present solid alloy chipper knife, which is now generally used throughout the chemical pulp industry, was first developed by the Heppenstall Co. during the period of 1932 to 1934. The entrance of this company into the machine knife industry came as a logical step following many years devoted to the development of solid alloy shear knives used in the metal cutting industries.

For purposes of definition, shear knives are used to cut metallic substances while machine knives are limited to those cutting nonmetallic substances; such as, wood, tobacco, leather, etc. Much to the chagrin of pulp mill superintendents, chipper knives, which are classified as machine knives, have been used occasionally to chip such nonmetallic objects as armor-piercing bullets, wedges, bed knives, conveyor links, and assorted bolts. The knife manufacturer is sometimes suspiciously happy about this situation but, if it will soothe anyone's feelings, we can report that the problem is not confined to any one mill or geographical location.

The chipper knife most commonly used before the solid alloy steel knife was a solid carbon steel knife of the 1% carbon tool steel classification. These knives were water quenched and tempered to a hardness of approximately 57 to 60 Rockwell "C" Scale. To be able to withstand the impact of chipping operations, the backs of the knives were softened so as to allow the knife to "give" when it struck a foreign object.

Using the above hardness as a starting point, we attempted to apply various tool steel grades to the manufacture of chipper knives. It is a tribute to the paper industry's desire for technological improvements, that a company such as ours, with no previous business associations with the industry, was permitted to make exhaustive, and many times costly, tests in the development of this new knife. In the period 1932 to 1934 we tested seven different analyses at eighteen different pulp mills before adopting two analyses as being suitable for chipper knives. Even today, many mills in the country are cooperating in testing new analyses and new designs.

Harold F. Wood, Jr., Asst. Sales Manager, Heppenstall Co., Pittsburgh, Pa.

Probably the most important test we made was one at a Pennsylvania mill in which, to meet a delivery deadline, we were forced to send out twelve knives, three of which, we felt, were too soft. The results of this test were somewhat disturbing for our research personnel The three knives which were supposed to be outside the hardness specification ran one 8-hr. turn, as compared to a 2-hr. run for the carbon knives, while the remaining nine knives, which were theoretically correct, broke on the initial installation. As a result of this test, we dropped our hardness specification to 52/54 Rockwell "C" Scale, which immediately allowed us to concentrate on the "high carbon-high chrome" type of steels. Mainly through the research procedure known as trial and error, we adopted the analysis of 0.80 to 0.85 carbon–11.00 to 12.00 chrome type. Continued research developed the "low carbon-high chrome" analysis of the 0.42 to 0.47 carbon–8.00 to 9.00 chrome type with 1.00 to 1.25 tungsten added for toughness, which is now used in over 75% of our knives. Profiting from the performance of the carbon knives, we softened the backs of these knives, a process we still use for all face-mounted knives.

The transition from "tailor-made" knives to volume production was accomplished without too much trouble since our shear knife facilities could be utilized completely.

MANUFACTURING PROCESSES

The actual processes used to manufacture chipper knives are considerably more complex than one would surmise by merely looking at a knife.

To maintain complete control of all operations of knife manufacture, one must produce tool steel ingots. We use the electric induction steel process, from which our trade name "E.I.S." is derived. The induction melting process provides a modern method of duplicating the quality of crucible steel, formerly made in small pots, producing ingots weighing only 100 lb. Our present E.I.S. furnaces have an ingot capacity of 3500 lb. each, which yield approximately 3000 lb. of quality steel. This very high ingot yield is only possible through the use of the electric hot top. This invention allows the ingot hot top to remain molten for a longer time, thus allowing molten metal to slowly flow into the ingot cross section as it cools. This eliminates the necessity for cropping the conventional sink head which oftentimes contains sound metal.

After the ingots are stripped from their molds, they are transferred to the forge department where they are heated to approximately 2100°F. and forged, by a 1000-ton press, into 10 by 4-in. billets. It requires one reheat to complete this reduction. These billets then are stress relieved by annealing at 1600°F. and then inspected for surface defects. Any defects are either chipped or ground out. The billets are again reheated to 2100°F. and rolled into the bars from which the knives are machined. The finish thickness of the knives determines the number of reheat and rerolling operations. In the rolling operation, we are limited to a 300°F. temperature drop before the billets must be reheated for further rolling. As the cross section of the billet becomes thinner and wider and the length increases, the faster the heat loss from radiation, with the result that the amount of work we are able to do during the 300°F. temperature drop decreases. These additional reheating and rerolling operations to obtain a small cross section explain why a chipper knife cannot be accurately priced on a per pound basis.

After rolling, the resultant bars are then annealed again at 1600°F. Because of the great variety of cross sections found in chipper knives, it is impossible, economically, to roll bars to within normal tolerances of all finish sizes. Instead each billet is rolled to approximately six different cross sections of about 3000 lb. each, which means that the machining losses are not constant. Naturally, on orders where the total weight approaches the minimum requirement on rolling weight, the bars can be rolled to closer tolerances.

After the bars are annealed, they are milled to the correct

cross section, allowing ample stock for decarburization and distortion in heat treatment. The bars are then cut to the correct knife length and the slots laid out and machined.

All are familiar with the program of slot standardization and the resultant saving by adopting a standard slot. It might be of interest to note at this point that, prior to the adoption of this program, blueprints indicated there were 215 variations of fifteen basic slots. These figures do not include slots with square corners inasmuch as sharp corners provide points of stress concentration and, therefore, cannot be used in alloy knives. Thus, our files did not show any of these type slots.

After the machining operations are complete, the knives are heat treated to standard hardness, depending on the grade of steel. The actual heat-treating operation is an ingenious cycle of high and low temperature salt baths wherein the knives are heated above their critical temperature in a high temperature salt bath. They are quenched in a low temperature salt bath and then air cooled. While being air cooled, the low temperature bath is brought up to the tempering temperature and the knives are tempered in the same solution in which they were quenched. The cycle is such that the quench, air cool, and temper operations require the same time as is necessary to heat untreated knives from room temperature to above the critical range. Thus, by the time the low temperature bath is cooled to the quench temperature, a new batch of knives is ready in the high temperature bath for the quenching operation. The use of salt baths is, also, desirable in that decarburization and distortion are reduced, there is no scaling, and a uniform temperature throughout the knife is obtained.

The heat-treated knives are then ground on the flats for hardness testing. In this connection, the knives are always tempered for the high side of the hardness specification because it is always possible to retemper the knives at a slightly lower tempering temperature if they test too hard. If they test too soft, however, the knives must be replaced since to reharden them, it would be necessary to first make them dead soft and then repeat the complete cycle mentioned above. Since some of the protective metal has been ground away preparing for the original hardness test, the decarburization and distortion inherent with the second hardening operation would cause the knives to finish undersize.

After the knives have passed the hardness test, they are finished ground to the correct size and then given their final inspection for dimensional accuracy.

PHYSICAL TESTING METHODS

In the testing of any material, there are two basic types of testing—destructive and nondestructive. Naturally, in making a finished knife, we are limited to nondestructive testing. From past experience, hardness reading can be correlated to physical strength, but it is most difficult to locate subsurface defects. In the heavey steel forging division the sonic reflectoscope has successfully been used to locate internal cracks in alloy steel forgings weighing up to 60,000 lb., but because of the varied surfaces of a chipper knife, due to the slots and bevel, this method is impractical. We have not been too successful in using various magnetic tests. We know that our grindermen have spotted internal cracks in knives as the filings will align themselves on the surface along the path of an internal crack when using magnetic holding chucks. We have not, however, been able to accurately determine the location of subsurface flaws by magnetic means. In one instance, we took several knives that we knew to be faulty and subjected them to various magnetic tests. In some cases, there were definite indications, but in other cases no indications were shown. Subsequently, the knives were broken under a press and subjected to a hot acid etch test. The cracks were clearly evident. As yet we do not feel that magnetic testing of high alloy steels has reached the commercial stage. For the more common alloy steels, however, it has been used with excellent results by steel fabricators everywhere. The magnetic testing of high alloy steels is one of our major research projects.

GRINDING OF KNIVES

The maintenance problems involved in the use of alloy chipper knives are varied and sometimes rather complex. For example: the grinding technique employed by the individual mills is, in general, poor.

It is often difficult to make the grinderman understand that alloy steels of the high carbon-high chrome classification require much more care than the 1% carbon tool steels used, for example, in most of the paper trimmer knives. In many cases, however, the equipment used to grind chipper knives is obsolete. We cannot stress too heavily the importance of using a modern grinder. In one mill, a new knife grinder, equipped with a magnetic holding chuck, reground knives with such increased efficiency that the mill was able to perform all of its regrinding operations on this grinder in 8 hr. By so doing, this mill was able to scrap two obsolete grinders which had previously been operated 24 hr. daily to maintain production. The savings in labor and power costs are obvious. The important point to remember is that a grinder designed for high alloy steels is inherently more efficient when also grinding the carbon tool steels.

Actual grinding instructions must be given in general terms and the individual mills must apply them to their own conditions. Unfortunately, the only factor that can be corrected immediately at each mill is the grinding wheel. The softness of the wheel and the grain size are most important. Too often a mill will purchase hard wheels because of their longer life, thus realizing a small cost saving, and then burn several hundred dollars' worth of knives which cannot be reclaimed.

It might be well to explain the meanings of the various symbols found on all abrasive products. The abrasive manufacturers have standardized on these markings so that it is possible for anyone to determine each wheel's grain size and hardness and to specify accordingly when ordering.

For example, two different makes of wheels, each of the same grade, recommended for chipper knife grinding are: 19A46-H8VBE and DGA46-H7V12.

The symbols common to both are the 46 indicating grain size and the H indicating hardness. The other symbols indicate manufacturing processes, bond, types of abrasives, etc. The numbers indicating grain size are as follows:

10 to 24—coarse 70 to 180—fine
30 to 60—medium 220 to 320—very fine

The hardness letters are as follows:

D through G—very soft
H through K—soft
L through O—medium
P through S—hard
T through Z—very hard

You will note that we recommend a medium grain size (46) and a soft wheel (H). Any wheel in these general classifications, however, will give satisfactory service for regrinding chipper knives.

The wheel speed and the table speed of the grinder, also, have a direct bearing on the grinding performance. We recommend a table speed of 60 to 80 f.p.m. and a wheel speed of 3500 to 4000 f.p.m. Naturally, if the grinder falls outside these limits, it would be well to go to a coarser and softer wheel to compensate for the grinder's deficiencies.

Coolant should be used at all times. Water is an excellent and inexpensive coolant. To prevent rusting add 1 lb. of soda ash to 10 gal. of water or 1 part of soluble oil to 80 parts of water. Most mills prefer soluble oil because of the unpleasant odor of soda ash.

The use of hand feed by the grinderman is most important. Automatic feed tends to become cumulative since most grinders do not have the power to maintain a constant feed, including the very heavy production grinders. The result is that the wheel will suddenly feed 4 to 6 thousandths causing serious damage. The use of hand feed has another inherent advantage. The grinderman is forced to watch his work more closely with the result that he dresses his wheel more frequently and does not allow it to become glazed as will be the case when the wheel rides on the knives without doing any work. We feel that a feed of not more than 2 thousandths per pass is desirable.

The use of a segmental holding chuck is strongly recommended. There is a segmental chuck for every grinder. By using a segmental chuck, the knives themselves act as a dresser each time a segment contacts the cutting edge. In addition, the air space between the segments allows the coolant to directly strike the surface being ground, which is most desirable.

We do not recommend that chipper knives be ground with the periphery of the wheel as this causes hollow grinding which lessens the cutting edge support.

A portable grinder is sometimes used to touch up the knives while they are still in the chipper. Extreme care must be exercised, however, since the small wheel has an exceptionally high peripheral speed and, if not moved quickly along the edge, will cause localized burning. We would suggest that a guide be made for the portable grinder so that the lateral movement does not destroy the original bevel. In addition, since this type of grinding must be done dry, a very coarse and very soft wheel must be used.

It is very easy for the individual mill to check its own grinding procedure. Since grinding cracks are rarely visible to the naked eye, the standard hot acid etch test must be used. Take an old knife and have the grinderman sharpen it as if it were to be put into service. Then immerse knife for 40 minutes in hot (160°F.) acid. Use 1 part hydrochloric acid and 1 part water.

There has been considerable controversy over the correct degree of bevel. Unfortunately, no standard bevel will work to everyone's satisfaction. Naturally, the smaller the angle, the greater is the chance of excessive nicking in service since the cutting edge has less support; the greater the angle, however, the more cards and increased power consumption. Our records show that the most common angle of bevel is somewhere between 36 and 38°.

CHANGING KNIVES

A more common problem in chipping operations is when to remove the knives for resharpening. It is axiomatic that dull knives increase power consumption, sawdust, and produce bruised and oversized chips. The most economical time, from a knife cost standpoint, is to remove the knives when they first begin to act dull. By changing knives at this time, less metal must be removed to sharpen them and the regrind time is greatly reduced. It is our opinion that this phase of knife costs is not watched too closely by the mills. We know from past experience that mills which sharpen their knives more often use far less knives than a mill of comparable size and chipping conditions, which allows the knives to operate after they have become dull. The problem, however, becomes the individual mill's responsibility. The end product determines the quality of chip required, but too often we find a mill spending considerable time and money correcting a situation by various processes that could be alleviated by better chip control.

One southern mill, however, has found that its production requirements are so great that they feel it is mandatory for them to operate a short time with dull knives so as to be able to replace the knives during a shift change. In our opinion, it would be better, however, for this mill to install a stand-by chipper to be used at certain intervals to maintain a constant flow of good chips. In this way, knife cost per chipper could be reduced and high quality of chips could be maintained. In addition, a periodic maintenance overhaul of each chipper could be made.

CHIPPER MAINTENANCE

Proper maintenance is of paramount importance. One mill, noted for its accurate records, reported to our company that our knives were giving them increasingly poorer service. A check revealed that the chipper had not been serviced in over 12 yrs. Fortunately for us, a new chipper was installed about this time and we have in our files a letter from an official of the company praising us for quick action in correcting a bad situation and reporting that the new knives were giving the same service as the mill had received back in 1938 and 1939. We did not deem it wise from a sales standpoint to advise this gentleman that the new knives were identical in analysis and heat treatment to the ones about which he had originally complained. If this cycle repeats itself, we can expect the same complaint from this customer in about 10 to 12 yrs.

Some typical examples of poor chipper maintenance would include worn bed knives, poor shaft bearings, loose spout bolts, broken or worn knife holders, well-pocketed knife bearing surfaces, and uneven knife pockets. All of these can be caught by periodic maintenance and corrected. Occasionally, knife failure has occurred as a result of uneven tightening of the holding bolts. The use of a torque wrench will eliminate this problem.

Oftentimes, we are asked for our opinion as to when knives should be scrapped. As mentioned before, all face-mounted knives are softened for a distance of approximately 1 in. above the top of the slot to the base of the knife. This is done to give the knife resistance to shock and the chipper foreman can readily tell when he reaches this soft metal In many cases, however, the operator is limited by the design of the chipper and is forced to scrap knives that still have a good part of their usable metal left. In many cases, we have suggested that, if practical, the bolt slot in the disk be lengthened so as to allow more possible settings of the knife. In some cases, a shorter slot in the knife can be used, thus allowing us to give you more usable metal.

Many mills using babbit metal instead of shims have found it possible to grind the knives down until the adjusting set screw holes appear through the cutting edge.

In some cases, mills have found that these holes can be shortened from the original specification, thus permitting more grinds per knife.

Other mills have made use of end clamps and changed their knife design so as to have the ends beveled for clamping purposes. The use of clamps holds more rigid and eliminates knife flutter to a great extent. Knowing this, the knife manufacturer is willing to harden more of the knife because the breakage risk has been reduced.

SUMMARY

Since all are interested in costs, it might be well to summarize some of the factors which we feel affect knife performance and, hence, knife costs.

1. Grinding equipment and grinding technique.
2. Correct bevel for individual mill operation.
3. Proper regrinding sequence.
4. Periodic chipper maintenance.
5. Correct installation.
6. Full knife utilization.

We know from experience that mills which check these six factors carefully can show a low knife cost per cord chipped which, in some cases, has been less than a penny.

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Instrumentation Studies. LXXXIII. A Summary of Instrumentation Reports Including the Technique of Evaluating Instruments

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Approximately 15 years ago, there issued a report which dealt generally with the status of the instrumentation program (*1*) under the sponsorship of the American Paper and Pulp Association. That report included a brief description of the purpose of the program, a classification and enumeration of paper properties, a summary of detailed studies which had been completed, and a tabulation of the available instruments for measuring the properties of paper.

Since the time of this first summary report, 27 new instruments or test methods have been critically studied and reported upon, four discussions of improvements or revisions in previously studied instruments or methods have been presented, and 12 reports have discussed individual or groups of properties without the application of particular instruments or test methods.

The scope of this program, which is unique in American industry, has been broad and is continually broadening. Instrumentation, by definition, deals with the use of instruments. Its importance needs no emphasis, for in a very real sense, the continued improvement in the quality and uniformity of every type of paper and paperboard depends upon *valid* instrumental evaluation of the properties of the furnish and the product. Although instrumentation nominally includes only the use of instruments, the instrumentation program has included not only the study of instruments but also that of noninstrumental test methods and the general conditions which affect the evaluation of the various properties of paper. In other words, the instrumentation program has dealt with the evaluation of the properties of paper in all its ramifications. This inclusiveness is not due to a loose decision as to whether a spatula, a stick of wax, or a stopwatch constitutes an instrument, but is due to the firm belief of the Subcommittee on Instrumentation Research that a clear understanding of paper properties and the factors which influence their measurement must form the general background for any critical study of instruments.

In thus considering the scope of the instrumentation program it is interesting to note that there are at least 46 properties of paper of sufficient importance to have inspired instruments for their evaluation and that there are more than 172 instruments available for measuring those properties! Twenty-nine of those 46 properties have at least been touched on in some report, and over 60 of the 172 instruments have been studied in detail or used for comparison with instruments so studied. The selection of properties and instruments for examination and the sequence in which studies have been carried on were determined by three factors—viz., the expressed interest of the industry, the availability of instruments or test methods, and the extent of available information on the property. As a result of the interplay of these three factors, it has not always been expedient to study properties and instruments in the order of their apparent importance to the industry and, therefore, it should not be judged that the neglected properties and instruments are the least interesting ones. On the contrary, some of these untouched fields are highly important as well as technically interesting. Needless to say, some present very stubborn and involved problems.

The body of this report is divided into two sections. The first section presents a brief description of the general method used in evaluating an instrument or a test method; the second is a nontechnical summary of the already available instrumentation reports. The bibliography lists the reports in numerical order.

THE TECHNIQUE OF EVALUATING AN INSTRUMENT OR A TEST METHOD

The purpose of evaluating an instrument or a test method is really manyfold. The results of the study should yield answers to the following questions: Does the instrument or method actually measure the property or properties as intended? If the instrument readings or test results are a measure of the property, how accurate a measure are they? If the property is one whose measure depends upon characteristic features of the instrument or test, how do the instrument readings or test results correlate with the corresponding readings or results of other typical instruments or tests which may be commonly used to measure that property? If the instrument or test has faults which limit its usefulness, what are the limits and the fields within which the method has value? If faults are found, can they be corrected or are they fundamental faults in principle or method? Is the instrument rugged? Is the method quick and convenient? Does the method require unusual skill or training for the operator? Is the maintenance cost high?

The technique of carrying on a study of an instrument or a method must vary in its details from case to case but its general features remain unchanged. In fact, these same general features of the technique are evident when a new instrument or method is being developed.

The first step in the evaluation of an instrument or a method is the establishment of the clearest possible understanding of the definition and significance of the

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property. If the property in question is a basic or fundamental property, little difficulty is encountered in this respect. If it is a use property, great difficulty may be encountered because of the varying significance attached to the property by technical men of the paper industry. In some cases, apparently divergent interpretations of the property may be reconciled. One such case was that encountered in the study of the Clark paper softness tester (*42*). Softness of facial tissues and toweling is related to the feeling when the paper is crumpled in the hand or against the face. Softness of glassines and waxed papers, used for wrapping bread, cheese, etc., is related to the ease of folding. In this latter case, if the paper is not soft enough the seals in the wrapper tend to pull open. If the paper is too soft, the wrapper does not keep its shape and therefore suffers in appearance. These two interpretations of the property of softness were closely related and the instrument readings were found to correlate reasonably well with subjective gradings according to both interpretations. In other cases, divergent interpretations of the property cannot be reconciled and it may be necessary to carry on the study with due consideration to each of the several interpretations. For example, smoothness may be associated with the finish of paper—i.e., with the fine-grainedness and uniformity of the surface texture, the gloss, and the feeling of the paper surface. Or, smoothness may be printing smoothness and refer to the uniformity and planeness of the surface presented to the printing form when the paper is on the printing press. Still a third case is occasionally found in which the interpretations of the property are divergent in such a way as to make it impractical to try to develop a simple evaluation of the property. Such a situation arose during a discussion of the property of whiteness (*76*). It was recognized that whiteness is judged by comparing the color with an ideal white. The difficulty was encountered in deciding upon the ideal white and it was impossible to make a decision because of the personal preferences of observers. One group favored a slightly yellowish hue, whereas another group preferred a slightly bluish hue. It was concluded, therefore, that no attempt should be made to develop an independent test for whiteness and that it should be specified as any other color by means of its visual efficiency, dominant wavelength, and purity according to the I.C.I. system of color specification.

The clearest possible understanding of the significance of a property is not always a clear understanding; the significance may both grow and change during the course of the instrumentation study. Perhaps a good example of this possibility is afforded by the study of the transparency of glassine papers and the development of the transparency meter (*15*) which was an outgrowth of a doctoral investigation by Wicker. The aim of the study was the development of an instrument for measuring transparency, which was previously judged visually. An understanding of the factors which influence the visual judgment of transparency developed during the course of the work and the final instrument was the result of a rather long series of experiments which demonstrated the connection between the physically measurable optical properties of the sheet and visually judged transparency.

The increased understanding of a property or a technique of measurement gained during the study of a particular instrument is not limited in usefulness to that particular study but becomes part of the background for future work. For example, the study of the Hunter multipurpose reflectometer (*23*) stimulated a theoretical investigation of the general limitations of all three-filter photoelectric colorimeters.

If the property to be studied is a basic one and the instrument employs well-established principles in a field in which other instruments or testing methods of known value are available for comparison, the evaluation of the instrument is direct and relatively simple, as in the case of the tensile testers (*46–48*) and the reflection meters (*21–25*). Any trouble that may be experienced usually occurs in trying to find the reason for some misbehavior of the instrument.

If the instrument does not employ principles which are well established and if other reliable instruments or testing methods are not available for comparison, the instrument must be evaluated by examining its principles and features individually to determine their compatibility with the intended use of the instrument. The studies of the Barss, Knobel, and Young news penetration tester (*33*) and the Larocque surface oil absorption test (*34*) illustrate this situation.

There are instances, of course, in which the test involves factors which are not understood well enough and which cannot be studied individually so that an important part of the evaluation of the instrument consists in comparing its readings with those of another instrument which measures the same property or group of properties. In considering the correlation between results obtained with two instruments, it is necessary to recognize that correlation over a large range is rarely, if ever, of use. There is no particular virtue in an instrument which can distinguish between newsprint and bond paper. Any papermaker can do that with his eyes shut. What is desired is an instrument which can distinguish between papers within the same class, and preferably it should distinguish more sharply than is possible by subjective methods. For example, the correlation between the Valley, Currier, and TAPPI methods for degree of sizing is very poor (*14*), not because it fails to show a trend over wide ranges in type of paper, but because the three methods fail to agree on the ranking of papers of the same type.

A point akin to this is the matter of the relative importance of precision and accuracy in an instrument or a test method. The precision or reproducibility of results of a test is good if repeated tests on the same sample yield results which agree closely and show little spread. The accuracy of test is good if the results are actually a measure of the desired property. If the results of repeated tests show a considerable spread, it may be because the property varies from point to point in the specimen, and the area tested is of such a size as to show up these variations. Hence, a method may be accurate and still appear to be of low precision because of specimen variation. A low degree of precision due to such a cause is not necessarily a fault of the method or instrument. It would constitute a fault if repeated tests on exactly the same area of a specimen failed to agree closely.

An example of the lack of meaning of precision when not accompanied by accuracy may be drawn from a

comparison of the Higgins reflection meter (*25*) and the Lange photoelectric reflection meter (*22*). The instruments are essentially equally precise. The Higgins instrument was shown to yield blue reflectance values in fairly good agreement with accepted values of papermakers' brightness. However, if one were to use the blue reflectance of the Lange instrument as papermakers' brightness, the error would be so great as to make the readings utterly useless, this despite the satisfactory precision. This point is important, for it is tempting to put more emphasis on reproducibility within a tenth of a per cent than on the accuracy with which the instrument measures the property in question. Accuracy of a tenth of a per cent is an admirable and infrequently found characteristic of an instrument or a method; precision of a tenth of a per cent is highly desirable and much easier to attain but meaningless unless accompanied by a comparable accuracy.

The demands are definitely less rigorous on an instrument to be used only for control in the manufacture of a particular class of paper than on an instrument for the testing of paper. For example, almost any reflection meter might be used to check the constancy of the opacity of a run of white paper, even though it might not be adaptable to the measurement of TAPPI opacity, might not have a photometric system with a linear response, or might not measure papermakers' brightness. The main requirement is that the instrument be accurate and sensitive enough to register differences at least as small, if not smaller, than can be detected by subjective means—i.e., by eye or by hand. For control purposes it is not necessary that the instrument agree particularly well with another instrument. In the testing of paper, however, the agreement of different instruments is of primary importance and such agreement is possible only if the instruments are sufficiently accurate and precise.

An instrument or test may be, and often is, useful even though it has faults and limitations. Smoothness testers, for example, are generally recognized to have limitations and to be far from ideal but they have demonstrated their value in maintaining the uniformity of a product. Hence, their use is justified for that purpose even though, for example, the interpretation of smoothness values in terms of printability of paper is a matter of controversy.

It does not follow, however, that a poor instrument is better than none. The necessity and urgency of pointing out the faults and limitations of instruments and test methods rest in the desirability of replacing human judgment by instrumental judgment whenever possible. *Such a replacement is well advised only when the behavior and limitations of the test are realized and understood so that no loss, confusion, or embarrassment may result.* Poor instruments poorly used damage the prestige of worth-while instruments; useful applications of instruments and new testing methods have sometimes been retarded or prevented because of previously unfortunate experiences with misused or unsound instruments. These instruments are responsible for a twofold financial loss—a loss of the investment in the instruments themselves and a loss in production which results from the ambiguous, misleading, or incorrect test results. Furthermore, these instruments may be responsible for the misdirection of research and the drawing of erroneous conclusions from the results of research. For example, suppose that the relationship between compressibility and printability of paper were being studied and that compressibility was evaluated, unwittingly, by an instrument which measured that property indirectly and poorly. If the correlation between printability and the instrument readings proved to be very poor, it would doubtless be concluded that there was no useful relationship between printability and compressibility, even properly and directly measured compressibility. Therefore, compressibility would be eliminated from the list of paper properties related to printing quality, to the detriment of much needed research on this project.

On the other hand, instead of thus discouraging research, a poor instrument is just as likely to falsely encourage research in an unprofitable direction. Because of poor sensitivity and accuracy and because of a complicated dependence on several properties other than the one of interest, the readings of an instrument may show apparently good correlation with some other measurement and thereby encourage additional work along that line. After more or less unfruitful research in this direction, a better instrument may, at first, show the original correlation to be less interesting and finally entirely useless.

However in spite of the mistrust caused by a few poor instruments and the misunderstanding of some good instruments, even the firmest holders of the belief that papermaking should remain an art rather than become a science are glad to shift, from themselves to an instrument, the responsibility for making decisions when the honesty of the instrument is proved.

From a quite different point of view, it is in the interests of the industry that the properties of paper be studied and understood and that testing methods and instruments be examined and their faults and limitations made clear before these methods and instruments are misguidedly used by consumers for the specification of paper. Furthermore, no matter how unpleasant the thought of the increasing inclusion of tolerances in the specifications of the properties of paper, the industry must be continually aware of the extent to which it can trust its testing instruments and methods for the establishment of such tolerances and for aid in the manufacture of paper within those tolerances.

The instrumentation program is carried on with these points in mind. The individual features of instruments and methods are examined critically and with care, not with the intent to be academic and to make a fetish of perfection but because the general and ultimate value of a method or an instrument is determined by these individual features. There are, in many cases, no adequate means of directly testing the suitability of the method for the intended purpose, and recourse must be had to examination of individual features as a basis for judging the probable value of the method as a whole.

Some of the reports on instruments and methods studied in the instrumentation program have more space devoted to discussions of faults than to praise of virtues. This may be ascribed to the fact that it requires less space to describe some particular test of an instrument and state that the instrument fulfilled the requirements satisfactorily than it does to describe a test, state that the instrument failed to fill the requirements, describe a corroborating test, and attempt to explain the reason for the failure of the instrument to pass the test. Re-

gardless of the space taken up by the discussion of good features, those passages dealing with faults quite naturally make unpleasant reading for the manufacturer of the instrument, or the originator of the method. Despite this unpleasantness, the manufacturers have generally recognized that the criticism was impersonal and unbiased and intended to be helpful, both to the industry and to the manufacturer.

In the case of several reports the reader will note that, in spite of the faults and virtues of a particular instrument, no final conclusion was drawn regarding the actual usefulness of the instrument. Such an omission is not satisfactory from the reader's point of view. It was sometimes necessary, however, because of the impossibility of putting the instruments to a direct test as part of the instrumentation program. For example, smoothness testers are claimed to find their principal field of usefulness in the evaluation of paper for printing. It was obviously impractical to carry on a thorough test of the relationship of smoothness to printability as part of the instrumentation program at the time those instruments were studied.

SUMMARY OF INSTRUMENTATION REPORTS

The second section of this report is a summary of all the reports which have been presented to the American Paper and Pulp Association as a result of the instrumentation program sponsored by them. This summary covers the reports which were summarized in the report of the Central Grading Committee in 1935 (*1*), as well as the reports presented since that time.

These 43 reports, a number of them having several parts, deal with the instruments or methods for measuring 27 properties of paper. For convenience, and to emphasize the mutual relationships of some of the properties, they are grouped into five divisions—i.e., optical, physicochemical, strength, structural, and surface properties. This classification is essentially that used in the first summary report (*1*) and is that used in Report No. 33 (*61*). The 27 properties to be considered in this summary are divided among these five groups in the following way.

Optical properties:
- Color
- Gloss
- Light transmission
- Opacity
- Reflectance

Physicochemical properties:
- Liquid permeability
- Moisture content
- Sizing
- Water-vapor permeability

Strength properties:
- Bending strength
- Compressibility
- Folding endurance
- Hardness
- Puncture
- Softness
- Stiffness
- Stretch
- Tearing strength
  - Continued
  - Initial
- Tensile strength

Structural properties:
- Air permeability
- Caliper
- Formation

Surface properties:
- Erasability
- Fuzz
- Smoothness
- Surface bonding strength

After first considering the reports of a general nature which do not conveniently fall in this classification, the following summary will take up the various properties in this same order. The Dictionary of Paper (*77*) is used as the source of definitions.

General

Early in the instrumentation program (*1*) it was recognized that the discussion of paper properties, as well as the testing of paper, was confused by misunderstandings of, and lack of agreement on, the definitions of these various paper properties. As a step in clearing up this misunderstanding, a distinction was drawn between fundamental properties and use properties.

When a sheet of paper is considered as an entity—as a single unit and not as an aggregate of smaller units—it possesses several properties which are distinct and definite, and which cannot be factored into component properties. These are the properties that are considered fundamental. They are: bending strength, color, compressibility, density, dielectric strength, elasticity, electrical conductivity, expansion and contraction, formation, hardness, light absorption, light transmission, porosity, reflectance, shearing strength, stiffness, stretch, surface contour, tensile strength, thermal conductivity, thickness, weight, and wettability.

There are several other evaluations commonly made on paper—evaluations which are normally considered as measuring specific properties, but which are actually affected by two or more fundamental properties, and which do not logically fall under the classification of fundamental properties. These factors are closely associated with the use requirements of the paper. The methods for their measurement have been developed in the main by simulating use conditions. The term "use properties," therefore, seems a satisfactory name for this group of measurements. It must, however, not be considered as including all properties that are direct measures of use requirements, since many of the fundamental properties are directly related to use requirements. The grouping seems to remove from the fundamental properties those which are the result of a combination of fundamental properties. The failure to make this distinction has been the cause of much confusion in the application of testing instruments and the interpretation of testing results. The evaluations so classed are: abrasiveness, absorbency, bulking, bursting strength, creasing strength, curling, degree of sizing, erasure, finish, folding strength, fuzz, gloss, opacity, permanence, permeability to various liquids, ply adhesion strength, rattle, resistance to wear, smoothness, surface bonding strength (pick test), tearing strength, and water-vapor permeability.

In considering these classifications of properties, it must be recognized that, in many instances, there is no official definition, and the connotation given depends upon the many uses that the term may have in the jargon of the trade.

These fundamental and use properties were defined (*19*). Some of the definitions are generally recognized and accepted, whereas others, as already noted, are

somewhat arbitrary and were presented as a basis for discussion.

The comparison of papers by means of physical tests is often rendered difficult because of the need for deciding when differences are really significant, particularly when the papers are in the same grade. When the differences are small, it is necessary to decide whether they are due to real differences in average properties of the papers, to errors resulting from inaccuracy in test methods and instruments, or to variations in the properties of different parts of tested areas—i.e., to inadequate sampling.

As a contribution toward the reduction of this difficulty, the lack of uniformity in properties was studied (*30*) for eleven typical papers of the sulphite writing class—viz., four bonds, three mimeos, and four ledgers. The furnish and the beating were the same for all papers of the same grade. Changes in basis weight were made by changes in machine speed only. Ten specimen sheets were selected, one from each reel; the ten reels were selected at random from runs lasting 24 hr. or more. Ten tests of each property were made, one test on each of the ten specimen sheets. The specimens were seasoned at 65% relative humidity and 70°F. for at least 24 hr. before testing and had been in equilibrium with a lower relative humidity before conditioning to testing conditions. The following properties were measured, using the TAPPI standard method when available: basis weight, bursting strength, caliper, folding strength, opacity, porosity, stiffness, stretch, tear, and tensile strength.

The report lists, for each sample, the average value of each property, the percentage average deviation, the maximum deviations, the percentage probable error of the average and, in addition, the average percentage probable error of the average for each class, and the average percentage probable error of the average for all classes. It will be remembered that the deviation of a particular reading is the difference between the particular reading and the average value for each set of ten specimens. The percentage average deviation is the average deviation divided by the average value of the property multiplied by 100%. Likewise, it will be remembered that the probable error in any quantity is the error within or without which repeated observation of that quantity will fall with equal frequency. Percentage probable error is the probable error divided by the average value of the property multiplied by 100%.

The data show opacity to be the most uniform property with an average percentage probable error for all classes of 0.29%; folding endurance is the least uniform with average percentage probable error for all classes of 6.08 and 8.20% in the machine and cross-machine directions, respectively.

The data collected in this study were made use of in another way. The close relationship between the samples in a given class afforded an opportunity for investigating the validity of a commonly used calculation. The test results for some physical tests, principally bursting strength and tearing strength, are sometimes converted to a common basis weight by dividing the test result by the basis weight and multiplying by 100 to obtain a result characteristic of a hypothetical 100-lb. sheet. This calculated result is commonly called "per cent points." If the calculation were a valid one, the per cent points should be approximatley constant for all basis weights within the same class. The calculated values are not satisfactorily constant for these three classes, and it is recommended that the use of per cent point values be avoided.

The important influence of moisture content upon the physical properties of paper prompted the preparation of a bibliography on the effect of relative humidity and humidity in the conditioning of paper for physical testing (*7*).

The importance of relative humidity in the testing of paper is not limited to the conditions under which the samples are seasoned before testing, but carries over to the history of the sample before seasoning. It has been known for some time that the moisture content of paper shows marked hysteresis in following changes in the relative humidity of the surrounding air—i.e., the moisture content of paper in equilibrium with an atmosphere of given relative humidity is higher when the paper is brought to equilibrium from an atmosphere of higher relative humidity than when brought to equilibrium from an atmosphere of lower relative humidity.

The corresponding hysteresis in seven other physical properties was studied (*8*) for 18 papers. The papers used included supercalendered book, English finish book, offset book, 100% rag bond, 100% rag ledger, index bristol, rag-sulphite manifold, sulphite mimeograph, sulphite bond, supercalendered waxing raw stock, sulphite glassine, butcher wrap, newsprint, blotting, and jute tag. The properties examined included: basis weight, bursting strength, expansion (hygroexpansivity), stretch, TAPPI size, tearing strength, and tensile strength.

The tests were conducted as follows: Before starting the tests all samples were seasoned at 30% relative humidity. This ensured their being in equilibrium with a relative humidity below that of the first test. The samples were then seasoned at 40% and tested, then successively seasoned and tested at 50, 65, and 75% relative humidity. They were then seasoned at 85% relative humidity but not tested; following this, they were successively seasoned and tested at 75, 65, 50, and 40% relative humidity. This procedure gave results at each of four relative humidities for paper seasoned to each of these from a lower relative humidity and another set of results for paper seasoned to each relative humidity from a higher relative humidity. All tests were carried out at 70 ± 1°F. The samples were seasoned for at least 12 hr. at each relative humidity before being tested. In making the tests the standard TAPPI procedures were used and special care was taken in cutting the test specimens to see that they were all representative of the samples being tested.

The test values at 65% relative humidity when approached from a lower relative humidity were taken as standard values and the differences between these standard values and the values at other relative humidities were calculated and listed. Of particular interest are the differences in the test values observed at 65% relative humidity when the relative humidity approached 65% from lower and higher values. The average percentage differences in the test values so obtained follow, the plus sign before the percentage difference indicating that the test value was greater when 65% relative humidity was approached from above than

when approached from below; a negative sign means the opposite: basis weight, +1.84; bursting strength, −4.90; expansion, +0.04; TAPPI size, −19.0; tearing strength, +2.88; tensile strength, −6.13; stretch, +13.58. The average percentage difference for TAPPI size does not include the values for the waxing stock, glassine, or newsprint as those samples showed a permanent structural change after seasoning up to 85%. Although the results of these tests are summarized by quoting average values for the differences found, it must be noted that the magnitude of the hysteresis varied for different classes of paper, as well as for different samples within the same class.

In addition to the examination of the hysteresis in these properties, a brief study was made of the hysteresis in gloss. Although relative humidity is not commonly considered as having an appreciable effect on gloss, it was suspected that very high humidities might have an important effect. Accordingly, four samples of coated book paper, which had been received during the winter months when the relative humidity was low, were tested through the same succession of conditions as outlined for the other tests, using the Bausch and Lomb glossmeter. Through the range of increasing relative humidity no appreciable effect was noted until 65% relative humidity had been passed. Beyond this point the gloss was materially lowered. At 80% relative humidity it was approximately 10% lower than at 65% relative humidity. The effect was quite permanent in that seasoning the samples to a lower relative humidity did not cause the gloss to return appreciably. By taking the samples all the way back to equilibrium at 40% relative humidity, the gloss recovered not more than 2 of the 10% lost between 65 and 80% relative humidity. Quite apparently relative humidities above 65% cause a change in the surface structure of coated papers.

The results clearly show the necessity of recognizing hysteresis effects when trying to make accurate measurements of physical properties. Where accuracy in testing is required it is recommended that all samples be seasoned for at least two hours at 35% relative humidity before being exposed to the standard condition for testing—i.e., 50 to 65% relative humidity.

Color and Reflectance

The investigation of instruments for the measurement of color and reflectance is more extensive than that for any other group of instruments. This is due to the importance of these properties in the paper industry, to the existence of well-established theory of their measurement, and to the rapid increase in the availability of photoelectric instruments for their measurement within the lifetime of the instrumentation program.

A general presentation of the physical theory of color and the measurement of color, reflectance, and transmittance was prepared (*20*). This discussion begins with a brief review of the nature of light and the significance of the spectrum. Emphasis is put upon the fact that the color of an object depends upon the illuminant, upon the direction in which the light falls upon the object, upon the selectivity with which the object reflects the various wavelengths of light, upon the direction in which the light is reflected to the observer's eye, and upon the characteristics of the observer's eye. *Reflectance* is defined as the ratio (for the same geometrical arrangement of illuminant, object, and observer) of the amount of light reflected by the object to that reflected by a properly prepared surface of magnesium carbonate or magnesium oxide. Since the reflectance of an object is, in general, not the same for all wavelengths of light, it is often necessary to make use of the spectral reflectance of the object—i.e., the distribution throughout the visible spectrum of reflectances for narrow bands of spectrum light. It is the spectral reflectance of an object which determines the selectivity of reflection mentioned above.

Since the color of an object thus depends upon other quantities than its own characteristics, it is pointed out that the quantity which uniquely describes the object is its spectral reflectance. Given the spectral reflectance curve of a sample, its color as seen by a normal observer under any illuminant can be calculated. Two samples having identical spectral reflectance curves will appear to any observer to have the same color under any illuminant. It does not follow, as a corollary to this statement, that two samples will never match if their spectral reflectance curves are not closely similar. It is common to find samples having quite different spectral reflectance curves which match satisfactorily under *some one illuminant.* It does follow, however, from both theory and practice that two samples having appreciably different spectral reflectance curves will not match under all illuminants. Because of the unique way in which spectral reflectance defines the color characteristics of an object many color measuring instruments make use of that fact—i.e., they are reflection meters. It is shown later, however, that all reflection meters cannot be considered color analyzers.

For transparent materials and solutions, spectral transmittance takes the role played by spectral reflectance for opaque materials.

The value of color analysis by means of spectral reflectance and transmittance measurements is suggested for paper, pulp, filler, dyestuff, and other components of the furnish. Further, the application of color analysis is suggested for such diverse problems as studies of dye retention, bleaching control, studies of the aging of paper, color control and dyeing, and for development or research work in general.

The virtues of "brightness" as measured on the General Electric reflection meter are discussed. Such measurements are particularly useful for white papers and fillers. It is pointed out that the brightness measurement is not a color measurement, since it is the reflectance for a rather narrow range of wavelengths in the neighborhood of 457 mmu (in the blue end of the spectrum). Caution is recommended in attempting to use brightness values alone in connection with colored papers.

The methods for the physical measurement of color are described and it is found convenient to discuss instruments for the photoelectric measurement of color in terms of three general features: the spectral characteristics of the instrument, which include the light source, the means of dispersing the light into the desired wavelength bands or intervals, and the characteristics of the photocell as regards its response to light of various wavelengths; the geometrical characteristics of the instrument, which include the optical system involved,

Fig. 1. General Electric brightness tester

the range of angles through which the light falls upon the sample, and the range of angles through which the light leaving the sample is collected and passed on to the photocell; and the photometric system—i.e., the method of measuring the intensity of the light reflected from the sample and from the standard of reflectance.

Most reflection meters use incandescent lamps as light sources. The radiation from these lamps includes light of all wavelengths in the visible spectrum and radiation of longer wavelengths in the infrared region of the spectrum. The distribution of energy or intensity with regard to wavelength is the most important characteristic of the light source. For incandescent lamps the relative intensity is least in the blue end of the spectrum and it continuously and rapidly increases as the wavelength increases through the visible spectrum and on into the infrared portion of the spectrum. This distribution of intensities, called the spectral distribution, of the lamp depends greatly on the temperature of the lamp filament. The spectral distribution of the lamp thus varies with the type of lamp, the operating voltage, the age of the lamp, and the nature of the glass envelope. The light from the lamp is split into the desired bands of wavelengths by dispersing the light into a spectrum by means of a prism or grating and then isolating the desired region of the spectrum, or by passing the light from the lamp through filters which transmit only the desired range of wavelengths. An instrument employing a prism or grating is usually called a monochromatic instrument or spectrophotometer, because, for practical purposes, the light isolated from the spectrum may be considered to be all of one wavelength. An instrument employing many (eight or more) filters which pass narrow bands of wavelengths is called an abridged spectrophotometer. Even the most satisfactory filters transmit a much wider band of wavelengths than that isolated from a prism or grating spectrum and the filters used in different instruments vary widely with regard to the width of the band of wavelengths which is transmitted. This constitutes an important difference in the spectral characteristics of the various instruments and is an essential factor in explaining disagreements in the reflectances measured with those instruments. The photocells used in reflection meters differ in type. The term "spectral sensitivity" or "spectral response" of a photocell refers to dependence of the photocell sensitivity upon the wavelength of light falling on the cell. The various types of photocells differ in spectral sensitivity.

The spectral distribution of the light source, the spectral characteristics of the dispersing or filter system, and the spectral sensitivity of the photocell determine the spectral characteristics of the instrument as a unit.

The geometrical characteristics of the various instruments vary over a wide range, but for purposes of discussion are conveniently grouped into four main types: First is the type preferred in the I.C.I. system in which the incident light strikes the sample at an angle of 45° with its surface, and the reflected light leaves the surface perpendicularly on its way to the photocell. Second is the type in which the light strikes the sample perpendicularly to its surface, and the light reflected at an angle of 45° with the surface of the sample is gathered by the photocell. Third is the type in which the light is incident perpendicularly upon the sample and practically all of the light reflected from the sample is gathered by an integrating sphere and part of it is passed on to the photocell. Fourth is the type in which light is incident upon the sample from practically all directions and the light reflected perpendicularly is seen by the photocell. There are, of course, hybrid combinations of these principal types.

The photometric systems may be divided into two categories: (1) direct photometry, in which the intensities of the light reflected from the sample and from the standard are directly measured and compared; or (2) indirect photometry, in which the intensity of the light incident upon the standard or of the light reflected from the standard is reduced in known fashion until the intensity of the light passing from the standard to the photocell is exactly equal to that passing from the sample to the photocell. In the second type of photometry, the reduction in light intensity is usually accomplished by means of polarizing prisms, sector diaphragms, iris diaphragms, neutral wedges, or wire screens.

A critical discussion of the mutual relationships of the

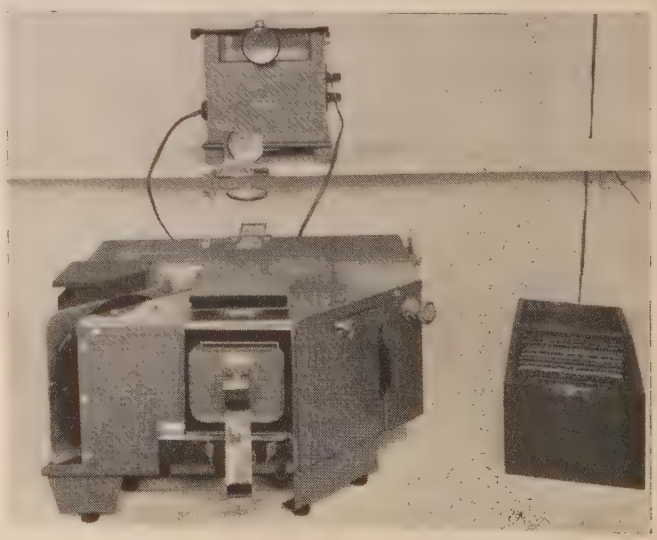

Fig. 2. Hunter multipurpose reflectometer

spectral, geometrical, and photometrical features of instruments for the measurements of both spectral reflectance and spectral transmittance is presented.

The I.C.I. system of color specification by means of the trichromatic diagram and the three quantities — visual efficiency (now called luminous reflectance), dominant wavelength, and excitation purity — is discussed.

The true colorimeter, whether photoelectric or visual, is an instrument by means of which the color of a sample seen under a given illuminant is specified by three instrument readings which are the tristimulus values corresponding to that color. The requirements which must be satisfied in order that an instrument be such a true colorimeter are discussed. The distinction between a true colorimeter and the many instruments bearing the name "colorimeter," "color analyzer," etc., is emphasized.

The *General Radio color comparator* was studied (*21*). This instrument is a reflection meter equipped with red, green, blue, and "daylight" filters and employing direct photometry. In the particular instrument which was investigated, the photoelectric currents indicated by the meter were not proportional to the light intensities incident upon the photocell. The instrument is not a true colorimeter. The ranges of wavelengths transmitted by the red, green, and blue filters are so wide that the reflectances obtained with the instrument do not agree well with the corresponding reflectances obtained with an accurate monochromatic instrument; in one case the reflectances differed by 40%. In common with all three-filter instruments, the three reflectances which are determined by this instrument are not sufficient to determine or indicate the course of the spectral reflectance curve of a sample. However, the instrument may be of practical help to the dye man when dealing with simple mixtures of dyes or in maintaining a given color during a long run. The reflectances obtained with the blue filter are greater than the brightness values obtained on the General Electric reflection meter by amounts varying up to 3 points.

The *Lange photoelectric reflection meter* was also studied (*22*). This is an instrument which is equipped with red, green, yellow, and blue filters and employs direct photometry. The response of the instrument is not linear—i.e., the photocurrents are not proportional to the illumination on the photocell. Some readings are

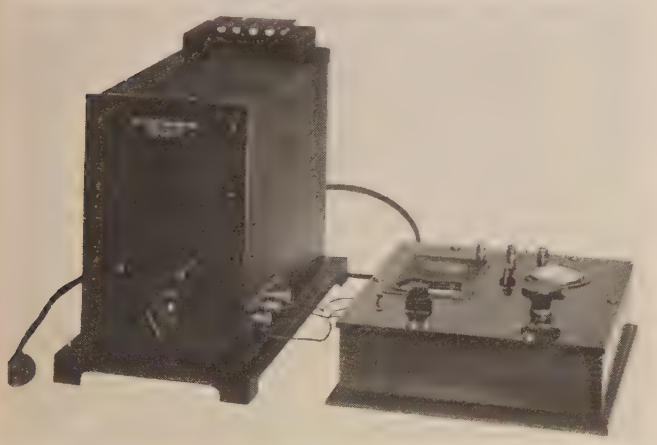

Fig. 3. Eimer and Amend reflection meter

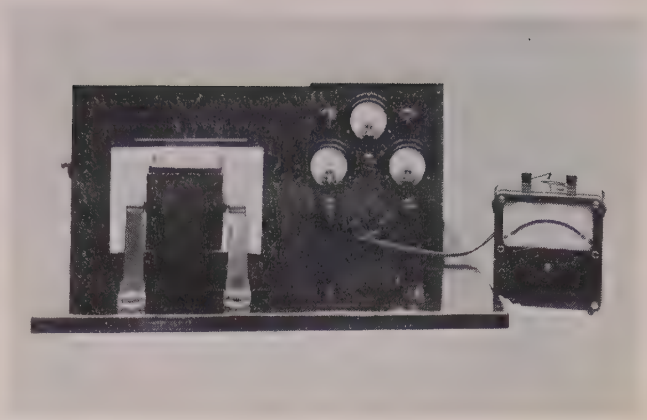

Fig. 4. Higgins reflection meter

in error by as much as 17%. The sensitivity of the instrument when used with the filters is inadequate. The instrument does not fulfill the requirements of a true colorimeter and the wavelength bands passed by the filters are so large as to make the instrument unsatisfactory for color control of any sort. No provision is made for the elimination of infrared radiation and all readings of the instrument are badly in error because of this infrared radiation. The readings of the instrument either with or without the filters bear no useful relationship to brightness as measured on the General Electric reflection meter. The design of the instrument is such that the gloss of the samples unduly influences the readings. The instrument does not seem to be suitable for use in the paper industry.

Another instrument included in this study is the *Hunter multipurpose reflectometer* (*23*). This instrument is designed for the measurment of reflectance, color, opacity, and gloss. Light is incident on the sample at an angle of 45° and the photocell receives light which leaves the sample surface perpendicularly. It employs three filters—amber, green, and blue—and employs indirect photometry through an unusual application of the inverse square law of light intensity variation. The reflectances measured on this instrument with its broadly transmitting filters cannot be expected to agree satisfactorily with the corresponding monochromatic reflectances. Reflectances measured with the Hunter reflectometer using the blue filter differ from values of brightness obtained on the G.E. reflection meter by amounts varying up to 1.7 points for white paper and up to 3.9 points for some colored papers. It is pointed out that any instrument designed for colorimetry—i.e., for measuring tristimulus values—cannot be used satisfactorily for measuring papermakers' brightness without the use of a different blue filter.

The manufacturer's literature describing this instrument frankly states that the instrument is an approximation to the ideal colorimeter. Comparison of the spectral response curves of the instrument with the curves for an ideal instrument shows that the response for the amber filter agrees fairly well with the ideal curve, the response for the blue filter is fair, and that for the green filter rather poor. The trichromatic coefficients of 32 papers, including both white and colored samples, were determined by means of the instrument and by calculation from spectrophotometric curves obtained with the first model of the General Electric recording

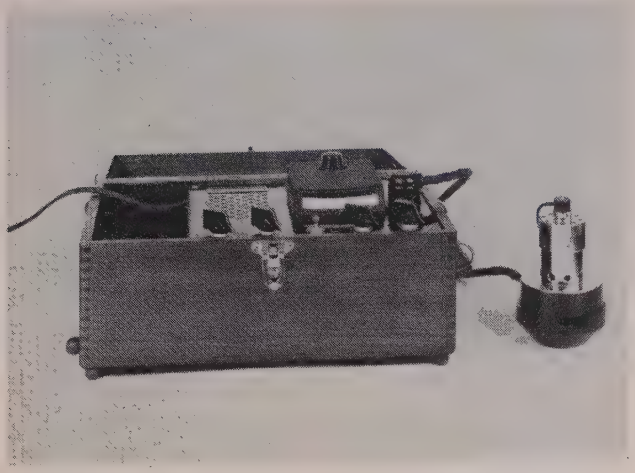

Fig. 5. Photovolt photoelectric reflection meter

spectrophotometer. The geometry of this instrument is equivalent to that of the Hunter instrument in that light falls perpendicularly on the specimen and light reflected at an angle of 45° is received by the photocell. It seems reasonable to make a minimum demand that an instrument of this type differentiate between colors at least as well as do average color matchers. Information as to the least perceptible differences in chromaticity (hue) for average color matchers of paper is meager. However, of the 32 samples examined, the instrumental trichromatic coefficients differed from the calculated values by 0.002 or less for only three white papers. Nutting has examined a number of pairs of commercial matches of cotton and woolen fabrics and finds that the average difference in trichromatic coefficients is 0.004. The instrumentally observed trichromatic coefficients differed from the calculated values by this amount or less for 15 of the 32 papers. The differences for all colored specimens were greater than this value.

Consideration of the limitations imposed by the fact that the lowest reflectance measurable with the Hunter instrument was 8.5% led to a theoretical discussion of the limitations of three-filter photoelectric colorimeters in general (*79*).

Despite the virtues and the limitations which have been noted, it is impossible to sum up the situation and come to a clean-cut decision as to the value of the instrument. The need for a good photoelectric colorimeter is great and values of color tolerances suitable for the paper industry are unknown. The value of the instrument must be judged through experience in actual use.

The *Eimer and Amend improved reflection meter* is another one of the group of instruments which was studied (*24*) as part of the program dealing with reflectance and color measurement. The manufacturers claim that the instrument is designed for the measurement of total reflectance, opacity, and translucency. The term "total reflectance" means that the reflectance measurement is made with light distributed throughout the whole visible spectrum. The light source, the optical system, and the photocells are such that the measured reflectance does not correspond closely to the I.C.I. visual efficiency and, hence, the measured reflectances do not correspond closely to visual estimates of "brightness."

The optical system is such that the observed reflectances depend upon the orientation of the sample. The changes in reflectance observed when the machine direction of a paper sample is rotated through 90° varies from 0 to 2%. This characteristic is common to a number of reflection meters. The large sample area (3 sq. in.) is a good feature of the instrument, since the large illuminated sample area reduces deviations due to local variations in reflectance.

The photometric arrangement of the instrument is good, the reflectance scale being accurate to within 0.2 reflectance unit. Auxiliary filters cannot be satisfactorily used with the instrument and, hence, it is unsuited for the measurement of specification of color or for the measurement of papermakers' brightness.

Another reflection meter and color measuring instrument which was included in the program is the *Higgins reflection meter* (*25*). This instrument is an abridged spectrophotometer designed for use as a control instrument for the measurement of brighteness (as brightness is defined by measurement on the General Electric reflection meter) and for the measurement of opacity. The light source in this instrument consists of three spotlights uniformly spaced around the sample opening so that light from each source strikes the sample at an angle of approximately 45°. The light reflected perpendicularly from the sample surface is received by a condensing lens and passes through one of the filters on the way to the photocell. The current from the gas-filled, emissive-type photocell is amplified by a type 36 vacuum tube and reflectances are directly read from a

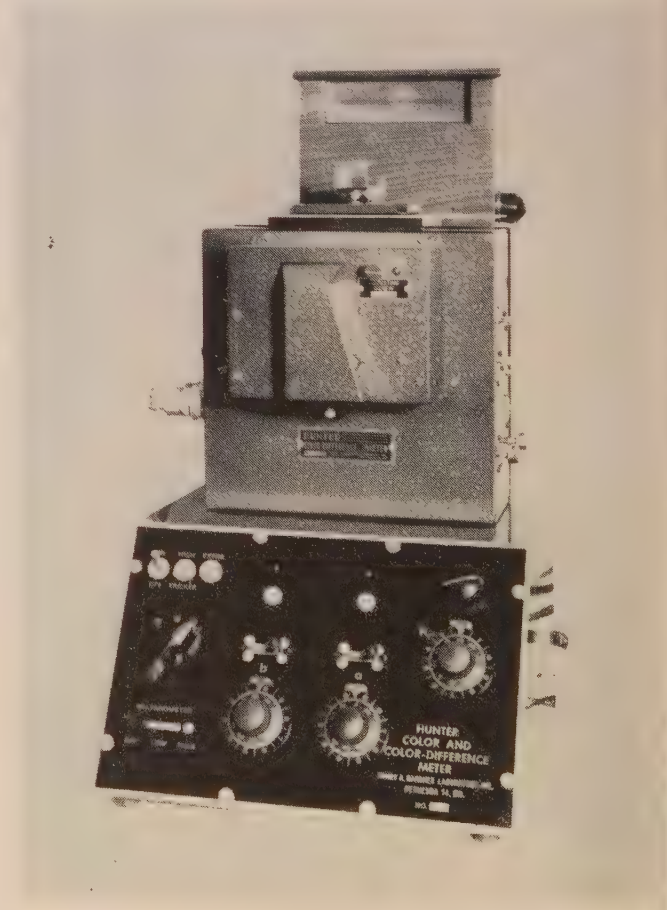

Fig. 6. Hunter color and color-difference meter

microammeter in the plate circuit of this tube. The photometric system is direct.

The spectral characteristics of the instrument are satisfactorily stable if the spotlight reflectors are polished at reasonably frequent intervals. Errors due to infrared fluorescence are negligible. The microammeter reading is not strictly proportional to the intensity of the light falling upon the photocell. This error is greatest through the middle of the scale and its maximum value is about 0.7 reflectance unit. A marked fatigue effect, evident by the fact that the microammeter needle approached its equilibrium position very slowly, was eliminated by replacement of the resistor in the grid circuit of the vacuum tube. The reproducibility of readings is adequate.

The three spotlights uniformly spaced about the sample opening illuminate the sample so uniformly that there is no grain effect and the observed reflectance is independent of the orientation of the sample. The sample opening is large so that good sampling is obtained. The clamping arrangement is so designed that large sheets of paper may be slipped into place without the trouble of cutting samples to a standard size. The direct reading feature of the instrument is preferred by many operators. Routine measurements can be made with greater speed on the Higgins instrument than on the General Electric reflection meter.

The brightness values of 46 samples obtained on the General Electric reflection meter were compared with appropriate reflectances measured on the Higgins reflection meter. The brightness values obtained with the General Electric reflection meter were the averages of ten individual readings, five with the machine direction parallel to the plane defined by the light source, sample opening, and photocell, and five with the machine direction perpendicular to that plane. The reflectances obtained with the Higgins reflection meter were the averages of three readings with the Wratten filter no. 49 in the light beam. The Higgins reflectances differed from the brightness values by 0.5 point or less in 32 of the 46 readings, by 1.0 point or less in 40 of the 46 readings, and the greatest difference in any of the readings was 1.1 points.

The *General Electric reflection meter* is discussed in considerable detail, both in regard to its use as a color analyzer, and its use in measuring brightness (*9, 10*). The instrument is an abridged spectrophotometer.

Fig. 7. Welch Densichron

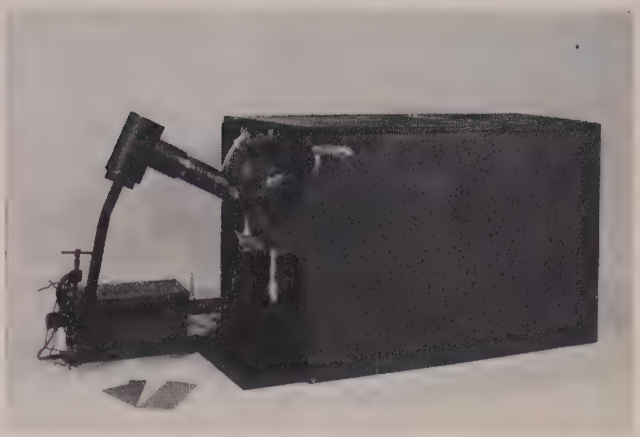

Fig. 8. Color blindness apparatus

Light falls on the sample at an angle of 45° with its surface and perpendicularly reflected light is seen by the photocell. The reproducibility of readings obtained with the reflection meter is discussed from both a theoretical and practical view with regard to the effects of focus of the lamp filament image, aging of the lamp, changes in battery voltages, changes in the transmission characteristics of the several filters, and changes in the spectral sensitivity of the photocell.

The nine filters of the instrument allow reflectances to be measured at nine effective wavelengths distributed through the visible spectrum. The fitting of these reflectances to the spectral reflectance curves obtained with the Hardy color analyzer is discussed and illustrated for typical papers.

A previously unknown effect is discussed—namely, a near infrared fluorescence. It was known for some time that the infrared radiation from the light source should be eliminated for two reasons: first, because of the undesirable heating effect and, second, because such infrared light contributed to the observed reflectances in spite of the fact that such light was not effective in the visual judgment of brightness or color. This new infrared fluorescence is due to the fact that visible light causes many samples to emit radiation in the near infrared part of the spectrum, even though no infrared light falls upon the sample. If this fluorescent light is not eliminated by the use of a proper filter, the observed reflectances are in error. The characteristics of such a filter and its placement in the path of the light leaving the sample and passing to the photocell are discussed. The use of this infrared stopping filter improves the accuracy of brightness measurement and also improves the agreement between the reflectances obtained with the other filters of the instrument and spectral reflectances obtained with the Hardy color analyzer. The use of this filter greatly facilitates the calibration of the reflection meter.

The changes in observed reflectance with the angles at which light falls upon the specimen and at which the specimen is viewed are discussed, as are the effects of surface structure of the specimen. The effect of irradiation of the sample is discussed. This irradiation effect deals with the penetration of the incident light into the sample and the consequent variation in the area and volume of the illuminated spot. This is particularly pronounced in the case of pot opal glass.

A *Photovolt photoelectric reflection meter*, Model 610, was also studied under this program (*26*). This instrument was designed for measuring the reflectance and color of solid surfaces, fabrics, pastes, powders, and opaque liquids. This instrument is provided with a search unit which contains the lamp, photocell, filters, and lenses as an independent part of the apparatus. The search unit is placed over the surfaces to be measured.

The intended geometry of the instrument is that of perpendicular illumination with viewing at an average angle of 45° over all azimuthal angles. Actual investigation showed, however, that the reflected light reaching the photocell contained an appreciable amount of specularly reflected light. The direct method of photometry is employed whereby the photocurrent is read directly on the galvanometer of the instrument, the deflection of which is taken as a measure of the reflectance. This method of measurement gave rise to a maximum photometrical error of about 2.0 points or 4% of the galvanometer deflection.

The Photovolt instrument is normally supplied with three filters (blue, green, and red). For this study, only the blue filter was used and the instrument was evaluated on the basis of its suitability for the measurement of brightness. It was recognized by the manufacturer that the blue glass filter with which the instrument was equipped would probably be unsatisfactory for the measurement of blue reflectance correlating with brightness. To examine this point, a series of papers and pulps of known brightnesses were evaluated and it was found that the Photovolt readings deviated from the standard brightness values by as much as −8.8%. Discrepancies of this order of magnitude are obviously too large to permit a reliable correlation between instrumental readings and brightness. By installing a more appropriate filter combination (Wratten 49 filter and a Jena BG-18 filter), smaller individual deviations were obtained. This served to indicate that it should be possible, by careful selection, to choose a filter combination that would give the proper effective wavelength.

This instrument is not satisfactory for the general measurement of brightness. When equipped with an appropriate filter and when properly standardized, the instrument could be of value for the routine control of brightness of a given grade of paper made under constant papermaking conditions from a given furnish. The procedure that is recommended for the standardization of this instrument, as well as for any other nonstandard reflection meter, is given on page 11 of Report 17, part IX, to the American Paper and Pulp Association (*28*).

Among the difficulties encountered in the use of the instrument are extreme dependence of stability on the constancy of power line frequency, the lack of provision for adequate adjustment of the lamp in the search unit, and the large rapid fluctuations that may be attributed only to poor electrical contacts in the instrument. It seems possible that most of these difficulties could be eliminated.

The *Hunter Color and Color-Difference Meter* (HCDM) studied under this program (*27*) is designed to measure color and small color differences by means of the three-filter photoelectric method of colorimetry. The HCDM is arranged to yield data in terms of Hunter's color diagram, in which a unit of color difference is intended to correspond to a uniform difference in color perception throughout the color solid; Hunter's scales are in R_d (percentage luminous reflectance, or $100Y$); a, which corresponds to greenishness through gray to redness on varying from negative through zero to positive values; and b, which corresponds to blueness through gray to yellowness on varying from negative through zero to positive values. The I.C.I. tristimulus values are not determined. The HCDM is intended to be used for color control, and cannot be employed for the determination of spectral reflectance curves, or for the measurement of papermakers' brightness. The values of R_d, a, and b are measured by reference to a color standard having colorimetric characteristics similar to those of the sample. In his description of the HCDM, Hunter presents the equations relating the values of R_d, a, and b with the I.C.I. tristimulus values X, Y, and Z of the sample under I.C.I. illuminant C. The adjustment of the responses of the several photocells, the choice of filters over the photocells, and the design of the circuit are intended to be such that the instrument performs in accordance with these equations. Means are presented for calculating a difference in lightness from a measured difference in R_d, and an equation is given which is intended to permit calculation of the number of color steps between two colors in terms of the differences in lightness, in a and in b. In terms of these units, it is claimed that the error in the HCDM is likely to be 4 units when there is a great difference between the colors of the reference standard and the sample, but that the difference drops to about 0.2 unit when the color interval between a standard and sample of a similar color is small. The unit on this scale is supposed to correspond to the "maximum (color) difference tolerable in the average commercial color match," and is equivalent to about three of the smallest visually detectable color steps (for a skilled observer).

This investigation of the HCDM has shown that it is a promising but not yet satisfactory device for the mill control of color. The particular instrument studied was found to have a few significant defects which should be eliminated to yield adequately accurate data on color differences. The various tests conducted to determine the accuracy of the HCDM showed that the b scale was seriously in error. These tests included measurements on a series of white papers, a series of Corning and Wratten filters, a family of yellow filters, a series of five families of dye solutions, and a series of two families of colored papers. In all but the last series, the majority of discrepancies were objectionably large and equivalent to many least perceptible differences. In two cases the error in the b scale accounted for discrepancies of 10 and 15 color steps. The larger discrepancies are attributed to the poor fitting of the blue filter system in the HCDM to that theoretically required.

The measurements made with the foregoing series of samples also indicated a defect in the a scale which accounted for a significant error in the instrumental readings. These errors were smaller than those obtained with the b scale but they could not be considered negligible. The defects in the a scale are attributed to an error in the adjustment of the photocell response or to an error in the circuit rather than to a mismatch of the spectral response function.

The phase of the investigation relating to such rudimentary factors as sensitivity, response to infrared radiation, effect of stray light, angle of incidence of the light beam and linearity of response, indicated that the HCDM was, in these matters, a well-designed instrument.

The *Welch Densichron* was investigated on this program (*28*) in a search for an instrument that would be relatively inexpensive and yet sufficiently accurate and precise to be of value in the mill control of brightness of pulp and paper. The Densichron is a new photoelectric instrument, designed primarily for densitometry. It is inexpensive, requires no batteries, and has such high sensitivity that it can readily be adapted to the measurements of reflectance.

In order to study the use of this instrument as a reflection meter, the photocell was mounted on auxiliary equipment that was designed to provide a simple means for measuring reflectance with filtered light. This tentative reflectance unit was arranged so that the surface of the sample was illuminated with a tiny lamp at an angle of 45° and viewed by the photocell at an angle of 90°. No lenses were employed; this was possible because of the great sensitivity of the instrument.

In the measurement of a series of papers of known brightness, it was found that the Densichron readings were generally in error. However, it was found that when the Wratten 49 filter was employed, and when suitable adjustments of the lamp voltage and the response settings were made, nearly correct results were obtained. It did not seem probable that all Densichrons could be so adjusted and it was felt that the discovery of an optimum combination of lamp voltage and response setting was accidental.

Investigation of the photometric accuracy of the Densichron revealed that the linearity error of the instrument was too large for the accurate measurement of reflectance. The linearity error depends upon the size of the aperture over the phototube window and also upon the response setting of the instrument. The instrument is based on a new method, and the manufacturer is actively engaged with instrumental improvements.

The reports on this instrument include a method of *specific calibration* recommended for the standardization of all nonstandard reflection meters. It has been shown that, when this method of standardization is employed, the Densichron correctly indicates the variability of brightness of the paper with a standard deviation essentially the same as that evaluated from data on standard brightness.

Color Blindness

The general problem of color blindness and its measurement naturally finds a place in this program in view of the large number of individuals throughout the industry who make critical judgments of color. Quite often a proper classification of the color vision of these individuals would lead to savings in time and money. Such classifications would lead also to an increased confidence in an observer who is charged with the responsibility for color match supervision if it were known that his color vision closely approached that of the internationally accepted I.C.I. (International Commission of Illumination) Standard Observer.

A discussion (*62*) of the requirements of a proper color observer in the paper industry is given, from which it is seen that color matches for this observer should be color matches for the normal observer and vice versa, and that differences in color should be observed and judged in the same way as does the normal observer.

The attributes of an observer which serve to classify his color vision are presented in tables and figures from the general literature on the subject. The tables include colors confused by the color blind, comparison of matches for persons having normal and abnormal color vision, and typical behavior characteristics of an individual during the performance of color discrimination. The figures present data which are the direct result of experimental observations of color comparison. These include curves showing the amounts of each of the red, green, and blue primaries required to match the spectrum colors; the difference in wavelength between spectrum colors which are just noticeably different in hue; differences in saturation corresponding to a just noticeable difference in color from the standard white; and the relative amounts of red and green which are additively mixed to produce a yellow. The various methods for testing color blindness are reviewed and it is concluded that, among these, there is no generally accepted color aptitude test nor is there any means of scoring the existing tests so that a quantitative measure of the degree of abnormality may be derived. It is pointed out that there is a great need for an ideal color aptitude test which will be independent of the color discrimination experience of an individual.

With this need in mind, a study of color blindness was made by means of a monochromatic colorimeter (*63*). This instrument, which is described in detail, provides a direct means for translating instrumental readings to points on a standard I.C.I. color diagram through which it is possible to characterize the color perception of an individual.

The thresholds of perception of color difference (limens) for several observers were obtained for five colors (blue, blue-green, yellow-green, orange, and red) distributed around the I.C.I. diagram. On the basis of the Ishihara, American Optical Co., the Glenn color blindness tests, four of the observers had normal color vision and three were red-green blind in varying degrees.

The limens are characteristic of the observer and it was found that large differences between the limens of the several observers existed. The differences between the limens of the normal observers were significant and interesting. The limen chart for a given individual is believed to afford important fundamental data for the individual which may be employed to describe that individual's sensitivity to color differences, and the legitimacy of color match, in a number of various color regions. Included with the illustrations of application of the limen charts is a discussion of disagreement between normal color matchers in practical color matching.

Gloss

A rather general report on the meaning of the term "gloss" and on the experimental consequences of the definition was prepared (*4*). The terms gloss, glare, finish, and smoothness are sometimes used almost interchangeably. Gloss, however, refers particularly to the polished surface of paper as produced by calendering or coating, and refers to the property a surface has of re-

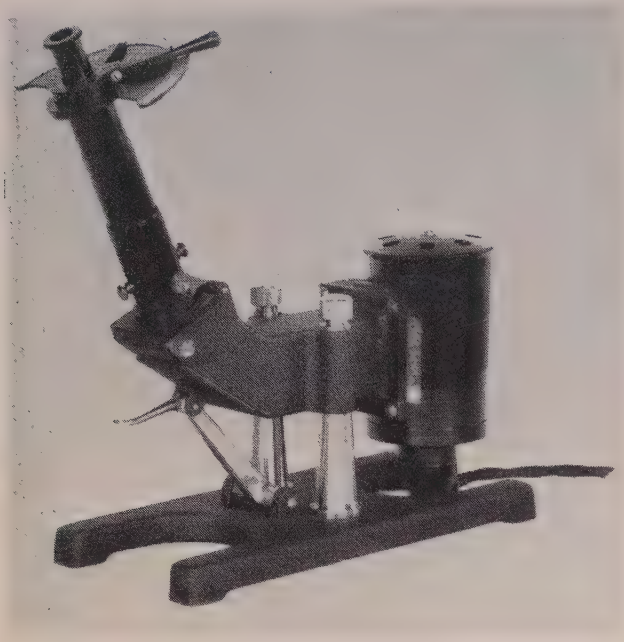

Fig. 9. Ingersoll glarimeter

flecting light specularly—that is, more or less like a mirror. Visual judgment of gloss involves not only a judgment of the amount of light specularly reflected but also an estimation of the contrast between the specularly reflected light and the diffusely reflected or scattered light. For example, a white and black glass of equal polish and indices of refraction are, by instrumental measurement, identical in gloss. However, by visual judgment, the black glass appears to be glossier because of the greater contrast.

In discussing gloss, it is necessary to remember that, at the surface of a transparent substance which is flat and polished, a certain portion of the incident light is specularly reflected, according to a law of optics which states that the angle of incidence of light is equal to the angle of reflection, whereas another portion of the incident light enters the substance in a direction depending on the angle of incidence and on the index of refraction of the material—i.e., this portion of the light is refracted; the relative amounts of light reflected and refracted depend on the angle of incidence and on the refractive index.

The surface of paper is not the flat polished surface of a transparent material in the sense just used. However, some specular reflection does occur. It is accompanied by a great amount of diffuse reflection which results from the many scattering points formed by the air-fiber, air-filler, and fiber-filler boundaries.

The variation of specularly reflected light with changes in angle of incidence and reflection was studied for a number of materials. The curves plotted from these data present percentage gloss, using a black glass as a standard, as a function of the angle of incidence of the light upon the sample. From these curves it is judged that an instrument which measures gloss in terms of the intensity of the specularly reflected light should be designed so that the light falls upon the paper at an angle between 10 and 25° with the paper surface. At this angle, the spread between different papers is greatest and there is the least dependence of gloss upon the opacity, color, and diffuse internal reflection of the sample.

The study of gloss was continued in a report which presented the correlation between *visual ranking* of papers and the ranking by the *modified Oxford glossmeter* and the *Ingersoll glarimeter* (*5*). The conclusion reached after several meetings of the Technical Subcommittee of the Coated Book Division was that the modified Oxford glossmeter gave better correlation with visual ratings than did the Ingersoll glarimeter, and that the instrument should have a fixed angle of incidence with the light striking the paper surface at an angle of 15° with the surface. The advantages of the modified Oxford glossmeter over the Ingersoll glarimeter are the following: (1) reduction of eye fatigue and elimination of personal judgment, (2) less effect from wrinkles and bulging of the sample, (3) a more representative area of the sample tested, (4) better correlation with visual rating, and (5) a greater spread for high gloss papers.

A later comparison of the *Bausch and Lomb glossmeter* (modified Oxford glossmeter) and the *Ingersoll glarimeter* was carried out in an effort to explain the differences in ranking of papers obtained with the two instruments (*11*). Gloss readings were made upon 72 coated book papers with both instruments. A curve is presented showing the correlation between the results obtained with the two instruments. There is a considerable spread among the plotted points. The deviations are explained in terms of the principles upon which the instruments operate. Gloss is measured by the Ingersoll instrument in terms of the polarization of the reflected light. The light specularly reflected from any smooth transparent surface is partially polarized and its degree of polarization varies with the angle of incidence, whereas the diffusely reflected light is unpolarized. The degree of polarization is a maximum at a particular angle which is determined by the index of refraction of the material. The design of the Ingersoll glarimeter is based upon the assumption that the index of refraction of paper is approximately 1.57, and the angle of incidence and reflection selected for the instrument is chosen to be appropriate to that index. Actually, coated papers vary widely in index of refraction. For example, calcium carbonate has an index of refraction of 1.5, whereas the value for titanium dioxide is

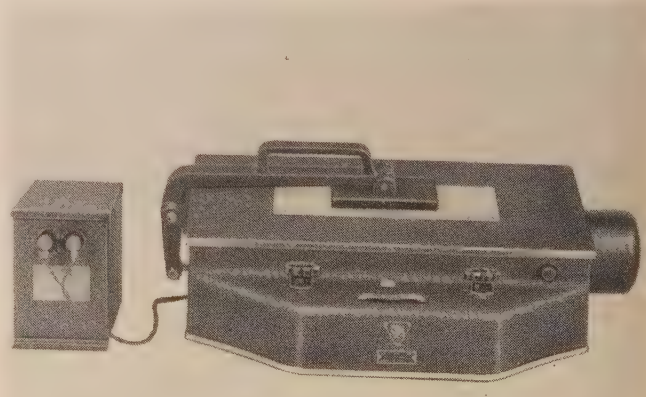

Fig. 10. Bausch & Lomb glossmeter

2.75. Because of this wide variation in the index of refraction of coated papers, the Ingersoll glarimeter does not give accurately comparable estimates of the degree of polarization of the specularly reflected light.

As previously described, the Bausch and Lomb glossmeter measures gloss in terms of the percentage of specularly reflected light, using a black glass as a standard, and this measurement bears no simple relationship to the percentage polarization of the specularly reflected light as measured by the Ingersoll glarimeter. Visual estimates of gloss are more directly connected to the amount of specularly reflected light than to the degree of its polarization; hence, the correlation between the visual gradings and Bausch and Lomb gloss readings is better than that between the visual gradings and Ingersoll glarimeter readings.

The *Hunter multipurpose reflectometer* (*23*) is designed to measure gloss, as well as color and opacity. It measures specular gloss—i.e., gloss in terms of specularly reflected light—as does the Bausch and Lomb glossmeter. Both instruments involve a special type of reflectance measurement and, therefore, the agreement of the two instruments is determined by the factors which influence the agreement of reflection meters in general, in addition to any factors peculiar to specular gloss measurement. The Hunter instrument employs angles of incidence and reflection of 45°, whereas the Bausch and Lomb instrument uses angles of 15°. In view of the earlier discussion (*4*, *5*) of the influence of the angle of incidence and reflection on the observed gloss values, it is to be expected that the readings of these two instruments would show rather poor correlation. The data presented in the report show this to be the case. The correlation between Hunter and Bausch and Lomb gloss (*23*) is not as good as that between Bausch and Lomb and Ingersoll gloss (*11*).

It is meaningless to talk of the differences as errors. Gloss is admittedly determined and "defined" by the characteristics of the particular instrument used. The relative virtues of the various instruments are determined solely by their relative usefulness in practice.

Light Transmission and Transparency

A study of the transparency of tinted white glassine papers was carried out and an instrument, the *transparency meter*, was developed for the measurement of transparency (*15*); this was an outgrowth of a doctoral dissertation by Wicker (*80*). A necessary preliminary to the study was the definition of transparency. After discussion with practical papermakers, it was decided that, for the purpose of this study, a transparent paper would be considered one which had the property of transmitting rays of light so that objects could be distinctly seen through the sheet. In practice, a visual estimate of the transparency of a sheet includes more than this definition alone; it also takes in the observer's estimate of the quality of the sheet as a uniform piece of paper.

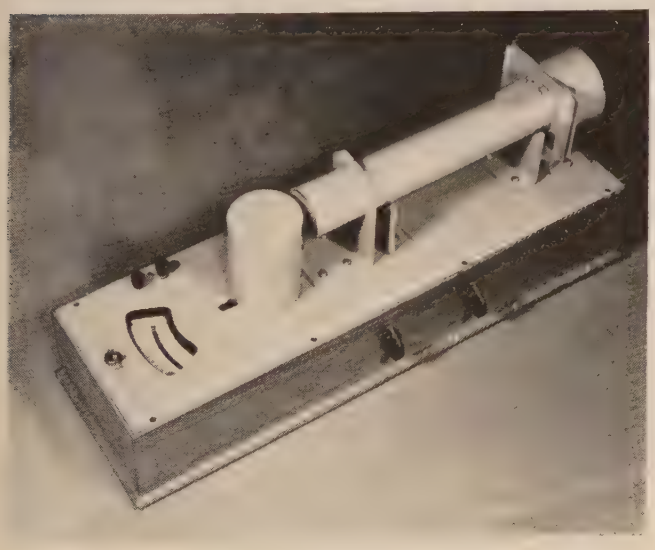

Fig. 11. Transparency meter

Fig. 12. Weston opacity meter

This definition prompts consideration of the mechanism by which light passes through such a material as paper. As light falls on a sheet of paper, part of the light is reflected at the surface and part passes into the paper. Of the light which passes into the paper, part is absorbed (a very small part, in the case of white papers) and the remainder is scattered; the scattering takes place in all directions, backward as well as forward; the light which is scattered backward and finally emerges from the sheet through the surface it entered is part of the diffusely reflected light; the light which is scattered forward and finally emerges from the opposite side of the sheet constitutes the transmitted light. It is the scattering of light within the sheet which controls the transparency. A material which scatters little light—such as a plate of glass—is highly transparent. On the other hand, a material which scatters light greatly—such as a sheet of book paper—is opaque and poorly transparent.

Having credited scattering with being the important factor in transparency, attention was directed to the experimentally observable quantities which are sensitive to scattering—viz., contrast ratio, image visibility, parallel transmittance, total transmittance, and transparency ratio. These quantites may be defined or described as follows:

Contrast ratio is the ratio of the reflectance of a sheet backed by a standard black surface to the reflectance of the sheet backed by a standard white reflecting surface. The lower the contrast ratio, the greater the transparency, and vice versa.

Image visibility may be described by considering the method by which it is determined. The sheet of paper is placed in contact with a printed black and white background. It is then assumed that the greater the visual contrast between the parts of the sheet over the white and the black background, the greater is the transparency. This contrast is expressed as the difference between the brightness sensations recorded by the observer. Image visibility is then defined as the difference of the brightness sensations for the background, as seen through the sheet, divided by the difference of the brightness sensations for the background when viewed directly—i.e., with the test sheet removed. The greater the image visibility, the greater the transparency.

Parallel transmittance is the ratio of the intensity of the light which passes through the sheet and emerges in the directions included in a cone of small angle coaxial with the direction of the incident light to the intensity of the parallel beam of incident light. It is highly dependent upon the characteristics of the instrument by which it is measured. The greater the parallel transmittance, the greater the transparency.

Total transmittance is the ratio of the intensity of the light transmitted by the sheet, regardless of the direction of its emergence, to the intensity of the parallel beam of incident light—i.e., it is the fraction of the incident light transmitted by the sheet. The greater the total transmittance, the greater the transparency.

Transparency ratio is the ratio of parallel transmittance to total transmittance. The greater the transparency ratio, the greater the transparency.

The outgrowth of these considerations was the development of the transparency meter for the specific purpose of evaluating the transparency of glassine papers. The specifications of this instrument are given. The effect of such instrumental variables as photocell sensitivity, lamp voltage, lamp filament focus, apertures, and the position and area of the photocell are discussed. The sensitivity, reproducibility of readings, and calibration of the instrument are also treated. The correlations of visual gradings by eleven observers with the instrumental values of contrast ratio, image visibility, parallel transmittance, total transmittance, and transparency ratio are demonstrated.

It is concluded that parallel transmittance is a good measure of the transparency of tinted white glassine sheets and can be used for mill control of such paper. It is emphasized that transparency ratio may be used for colored as well as white sheets and is the best general measure of transparency.

Opacity

A general discussion of opacity and of methods for the measurement of opacity was prepared (*35*). The distinctions between opacity, translucency, and transparency are emphasized. A body is *translucent* if it passes light but scatters it so strongly that objects cannot be distinctly seen through it; it is *transparent* if it permits the passage of light and scatters it to such a small extent that objects can be distinctly seen through it; it is *opaque* if it is impervious to light. The meaning of these concepts is amplified in terms of the angular distribution of the light transmitted by the paper.

The use of contrast ratio, printing opacity, and transmittance as measures of opacity is discussed.

The meaning of *contrast ratio* is illustrated by the following experiment: Imagine the sample to be uniformly and diffusely illuminated with white light. A black cavity is placed behind a portion of the sample and a white reflecting surface is placed behind another portion of the sample near that covered by the black cavity. The sample is then viewed in a direction perpendicular to the surface of the sample. If the sample is not perfectly opaque, that portion which lies over the black cavity will appear darker than that which lies over the white surface. The ratio of the brightness of the portion over the black cavity to that of the portion over the white surface is the contrast ratio. It is obvious that the contrast ratio for a given specimen will depend upon the choice of the white backing surface.

Instrumentally determined values of contrast ratio may be subject to the errors common to all reflection meters and, in addition, are subject to an error peculiar to the measurement of contrast ratio. This error is associated with the "effective reflectance" of the white backing surface or "white body." This white body is commonly a block of magnesium carbonate protected by a cover glass which is spaced above the magnesium carbonate block. The spacing between the cover glass and the carbonate block and the thickness of the cover glass influence the effective reflectance of the white body.

TAPPI opacity is a particular contrast ratio obtained with a white body of specified effective reflectance. A method of obtaining TAPPI opacity by means of measurements made with a spectrophotometer or an abridged spectrophotometer and by use of a Bureau of Standards chart, is described.

Printing opacity is the ratio of the reflectance of a single sheet of the specimen backed by a black cavity to the reflectance of the sheet backed by an opaque pad of the paper. This measurement is not influenced by the error peculiar to the measurement of contrast ratio, since the effective reflectance of the white body does not enter into the measurement. Of all the quantities that are determined from reflectance measurements, printing opacity is probably least subject to instrumental error.

Printing opacity is the correct and most direct measure of the opacity which is visually judged by the show-through observed in the top sheet of a pile of similar sheets bearing printed or written matter; i.e., printing opacity measures the contrast between the area of a sheet backed by printed matter and the area backed by a thick pad of similar paper. Contrast ratio measures the contrast between areas of a sheet backed by any two backgrounds.

Some inversions will occur in the ranking of a group of papers by printing opacity and contrast ratio. The inversions should not be serious for ordinary white papers; the worst inversions will occur in the case of comparisons of white and gray or other colored papers. In spite of these inversions and because of the greater simplicity and freedom from troublesome calibration, it is suggested that more serious consideration be given the possibility of using printing opacity in place of TAPPI opacity.

Although transmittance measurements may be precise in the sense that reading are highly reproducible, the measurements depend upon so many instrumental variables and upon the characteristics of the sample in

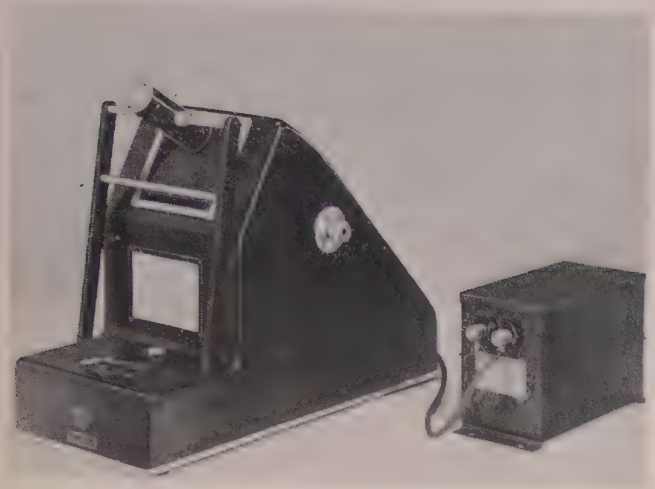

Fig. 13. Bausch & Lomb opacimeter

such a way that they cannot be considered fundamental and a substitute for other measures of opacity. For certain purposes of mill control, a simple measurement of transmittance may be useful, but it is not reliable for comparing different papers.

In this connection brief studies were made of the *Westinghouse Trans-O-meter* (*15*), the *Weston Opacity Meter*, and the *Welch Densichron* (*37*). Generally good correlation was found between readings obtained with these instruments and the Bausch and Lomb opacimeter; however, there were instances where the deviations for individual papers were rather large. The data indicate that a stable transmission instrument should be effective for the mill control of opacity if its calibration for the papers in actual production is checked against a standard opacimeter at reasonably frequent intervals.

Opacity—i.e., contrast ratio or printing opacity—may be measured with any reflection meter. The agreement between opacity values obtained with different instruments depends upon the same instrumental features that govern the agreement between reflectance values in general. These features were considered in the discussion of color and reflectance measurement (*20*). Just as the failure of two reflection meters to yield the same reflectances because of differences in spectral or geometrical characteristics is no fault in itself, so the failure of two opacity measuring instruments to yield the same opacities for the same reasons is no fault in itself. The failure becomes a fault only if the two instruments are intended and claimed to measure the same quantity. It is in this light that comparisons should be considered between reported opacity values obtained with the Bausch and Lomb opacimeter and the Eimer and Amend reflection meter (*24*), the General Radio color comparator (*21*), the Hunter multipurpose reflectometer (*23*), the Weston opacity meter, and the Welch Densichron (*37*).

The calibration of the *Bausch and Lomb opacimeter* is discussed (*36*) and detailed instructions are given for adjusting the spacing between the cover glass and the white body so that contrast ratios obtained with the instrument are TAPPI opacities. This calibration is effected by using the instrument to measure the absolute reflectances of properly selected paper samples and by the use of a Bureau of Standards chart. The reflectances measured are the reflectances of a single sheet of the sample backed by the black body and the white body, and the reflectance of an opaque pad of the sample.

Reflectance

Because of the intimate relationship betweenr eflectance and color, reports on reflectance measurements and instruments are discussed in the earlier section on color.

Transparency

Reports on this subject are discussed under the more general heading of light transmission.

Liquid Permeability

The penetration of papers by liquids and solutions is a process of general interest to the whole paper industry. It is of particular importance to some divisions of the industry—e.g., to the manufacturers of impregnating papers and of greaseproof papers. Whether the aim is a paper which is rapidly and completely permeated by a particular liquid, a paper which is as impermeable as possible, or a paper of intermediate characteristics, the development and manufacture of that paper should be facilitated and expedited by intelligent consideration and application of existing knowledge of penetration processes. Tests intended to evaluate paper for a particular use must be designed with care in order to simulate, if not duplicate, the penetration phenomena occurring in actual use. Last, but not least, similar intelligent consideration must be given the penetration processes obtaining in the use of the paper—e.g., the relationship of ink to paper in printing.

A discussion of the penetration of paper by liquids and solutions was presented (*32*). This discussion includes a summary of the pertinent facts relating to the flow of fluids through capillaries. It points out that the actually complex structure of paper cannot be adequately described by any combination of simple capillaries. It is emphasized that the justification for applying an oversimplified theory to a complex situation rests entirely upon the usefulness of the results obtained. Danger lies in reading out of these results an interpretation involving too much of the simple picture upon which the theory is based and in drawing deductions of too far-reaching a nature. With this background, the penetration of liquids and solutions into paper is discussed. Mention is made of the possibility of describing penetration processes by statistical methods which deal only with the experimentally observable quantities and involve no picture of the actual mechanism of penetration.

The second section of this same report deals briefly with the evaluating tests for paper which involve penetration by liquids. The tests are classified, for the purpose of discussion, into three groups: first, those tests which involve complete penetration or transudation of a sheet; second, those tests which involve only partial penetration of the paper; and third, those tests which deal only with the rate of penetration.

Among the penetration testers which have been examined is the *Barss, Knobel, and Young news penetration tester* (*33*). This instrument is intended to measure the resistance of paper to the penetration of water

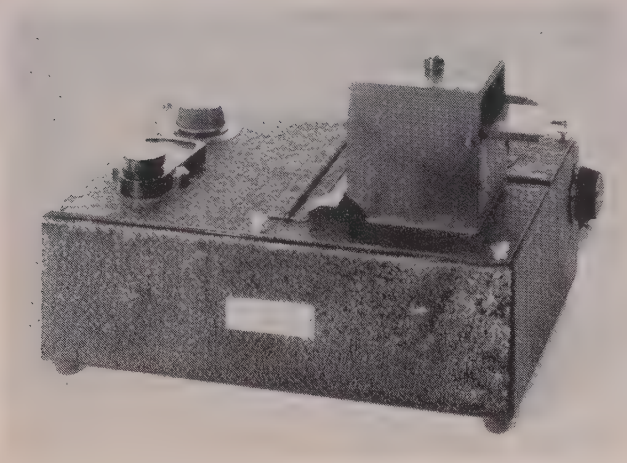

Fig. 14. Barss, Knobel, and Young news penetration tester

and oils or ink. The resistance to penetration is measured by the time required for a dyed water or oil solution to penetrate into the sheet sufficiently to reduce the reflectance of the opposite side of the sheet to a predetermined fraction of its initial reflectance.

It is shown that in many cases the dye in the water or oil solution is adsorbed by the surface fibers of the sheet and that the reduction in reflectance as penetration proceeds is not due so much to the fact than an increasingly thick fraction of the sheet is becoming opaque to light as to the fact that the penetration of the solvent into the sheet reduces its opacity and reflectance so that more light passes through the sheet and is absorbed by the dye at the surface of the paper. In many cases, therefore, the observed times are not directly related to the fraction of the sheet penetrated as is postulated in the theory of the instrument operation. This is experimentally demonstrated by the fact that the ranking of a group of papers by the instrument is the same whether a dyed or an undyed oil is used as a penetrating liquid. It is shown that the instrumental readings are definitely dependent upon the color and opacity of the sample. This fact constitutes a serious objection to the use of the instrument unless the papers tested have essentially identical optical properties. In order that color may be more accurately taken into consideration, theory was applied and charts were prepared by use of which more reliable results are obtained when superficial dye absorption does not occur.

Another penetration test which has been examined as part of the instrumentation program is the *Larocque surface oil absorption test* (*34*). This test was developed by Larocque with the intent of distinguishing between the penetration of oil into the surface of paper and the deeper penetration of oil which is measured by other tests—for instance, the conventional oil drop test in which the penetration into paper is considerable. Many properties of paper are known to vary from point to point through the sheet and, as mentioned in the general discussion of penetration phenomena (*32*), the absorption or rate of penetration of oil at the surface of a sheet might be quite different from that within the sheet. Since printing is considered to be primarily a surface process, Larocque intended this test to differentiate the printing quality of various papers more sharply than the conventional oil drop test.

In this test a small measured quantity of oil is extruded from the end of a capillary and allowed to distribute itself over the finely ground surface of the end of the tube. The paper specimen is lightly pressed against the end of the tube, transferring the oil film to the paper, and the time interval between application of the oil film and disappearance of the shiny oil surface, when the specimen is viewed in reflected light, is noted.

The reproducibility of absorption times was studied and undesirably large variations were noted. These variations are attributed primarily to inadequate sampling (an inherent characteristic of the test), to difficulty of judging the end point, and to the effects of the pressure of application of the oil film. The observed absorption times were found to be quite sensitive to the pressure with which the paper specimen is pressed against the end of the capillary. Because of this lack of reproducibility, the test fails to rank samples consistently. It was observed that the oil penetrated a considerable fraction of the sheet despite the fact that a very thin film was initially applied. The correlation between the ranking of samples by this test and by the conventional oil drop test is good enough to indicate that both tests measure essentially the same property and thus it appears that this surface oil absorption test fails in its intended purpose to measure only the surface property of the sheet.

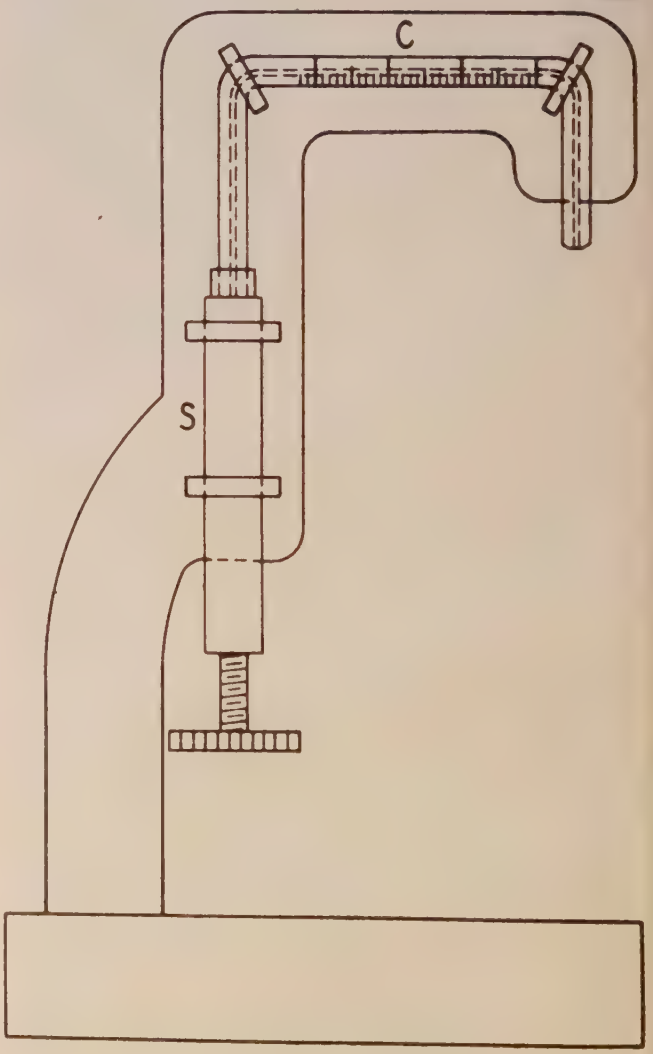

Fig. 15. Larocque surface oil absorption apparatus

As part of the instrumentation program, the *I.P.C. oil penetration tester*, an instrument particularly suited for measuring the rate of penetration of oil through uncoated printing papers, was designed (*16*, *17*). This photoelectric instrument makes use of the fact that the intensity of the light transmitted by a sheet of paper increases as oil penetrates through the sheet. The transmittance of the sheet is observed before and at suitable time intervals after application of the oil. The data are plotted and the speed of penetration (e.g., millimeters per second) at any time after application of the oil may be calculated from quantities obtainable from the curve. It is pointed out that the speeds calculated for times very shortly after application of the oil are questionable. The design of the instrument, its theory, and tests which justify the theory are presented.

Sizing

The correlation between *Valley*, *TAPPI*, and *Currier size tests* is discussed and illustrated (*14*). The results confirm previous indications that only a very general correlation exists between different methods. Bond, butchers wrap, kraft, coated book, mimeograph, and lithograph papers were tested and, considering all of these classes, correlation between the Valley test and the other two is more erratic than correlation between the Currier and TAPPI methods. As previously pointed out, in tests of this sort, good correlation for papers of a single class or related classes is more desirable than for widely different papers. The Valley test does not seem to give a reliable measure of the resistance to penetration of water. The principal conclusion is emphasis upon the need for a more complete knowledge of the measurement of this property.

The *Barss, Knobel, and Young news penetration tester* (*33*) is designed for the measurement of sizing as well as oil penetration. The comments made in the preceding discussion of liquid permeability in general apply here. The correlation between the instrument readings and TAPPI size times for 13 papers ranging from mimeo to butchers' wrap is presented. As in the comparisons of the other size tests, the correlation for the entire range is much better than that for the papers of a single class.

Fig. 16. Currier size tester

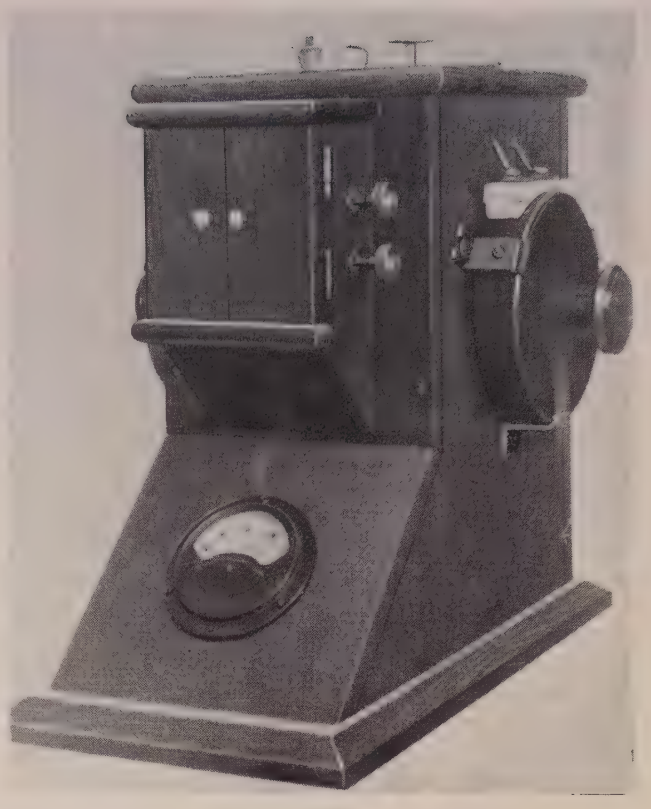

Fig. 17. Valley size tester

One instrument developed during the past several years that has considerable merit is the *K.B.B. size tester* studied under this program (*75*). The K.B.B. tester consists simply of two electrodes of dissimilar metals (one composed of zinc and the other of porous bronze saturated with water) that are separated by the test specimen and connected to a microammeter. The pair of dissimilar metals and the paper specimen form a galvanic cell; no other source of e.m.f. is present in the circuit. As the water (supplied by the saturated "Porosint" disk) penetrates into the paper, the resistance of the paper decreases, and the current indicated by the microammeter increases. In the normal use of the instrument a stop watch, which has been started at the start of the test, is stopped when the current attains 80 microamperes, the observed time being taken as the size time.

In this examination of the K.B.B. instrument, in which a large variety of different papers were evaluated and the results compared with data obtained with the TAPPI, Currier, and fluorescence methods, it was found that a rough correlation existed. There were certain serious inversions, but it was observed that these were no larger than the deviations observed in the comparison of the data obtained with the other methods.

Thirteen principal conclusions are listed at the end of the report. The last of these is as follows: "The K.B.B. size tester is markedly superior to the TAPPI (dry-indicator) test. We believe that it is the best of simple size testing methods, but probably not as accurate as the fluorescence size tester and perhaps other research methods. Certain improvements. . . should be investigated by the authors of the test and effected if feasible."

Water-Vapor Permeability

Because of their use in packaging and housing, papers designed to resist the passage of water vapor are of considerable importance. A study of the property of water-vapor permeability was therefore begun (*49*). A bibliographic survey (*52*) has also been made of those methods which have been used for the measurement of water-vapor permeability prior to 1944.

The well-established facts that water-vapor permeability is not related to the permeability to liquid water, and is not simply related to porosity or air permeability are mentioned. The relationship between rate of transfer of water vapor through the sheet and differences in relative humidity across the specimen, average relative humidity, differences in partial pressures of water vapor across the specimen, temperature, and time of test are discussed. The method of measuring water-vapor permeability by means of the *Thwing Vapometer*, or its equivalent, is considered and particular attention is paid to the proper characteristics of the tare which is necessary in making weight determinations and to the resistance to diffusion of water vapor which is offered by the air space between the liquid or desiccant in the cup and the specimen.

A new method is proposed for continuing the study of water-vapor permeability in the laboratory. The method may not be satisfactory for routine use in the mill but it offers advantages for a general study of the property which may lead to improvement in the present method or to the development of a new method for mill use.

When the exigencies of the war introduced the necessity of using improved wrapping and packaging materials, the requirements with regard to the permeability characteristics of such materials became more severe. Consequently, it was desired to develop and investigate techniques of measurement in which the materials would be subjected to conditions more nearly simulating use conditions.

Techniques for measuring the water-vapor permeability of creased and uncreased materials at 100°F. (*51*) were developed. In this method a variation of the cup method is employed with one side of the material exposed to a relative humidity of 92% and the other to a relative humidity of 23%. The creasing procedure employed is discussed. The application of an electric hygrometer to the control of relative humidity in a testing room or cabinet is described and a vacuum tube control circuit which may be used with the electric hygrometer is presented.

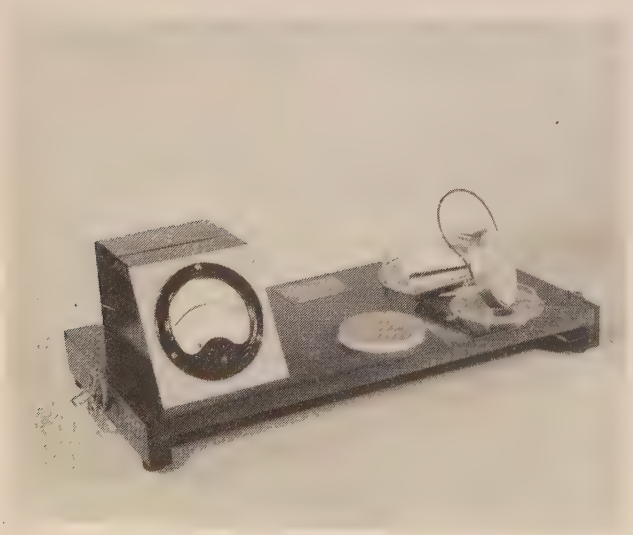

Fig. 18. K.B.B. galvanic size tester

Fig. 19. Creaser for WVP testing

In the development of a method for the *measurement of water-vapor permeability at low temperatures* (*56*), the application of the dynamic method (*53*) was investigated. The dynamic method employs the electric hygrometer and was originally developed for production control purposes where a sensitive and rapid means of evaluation is desired. The high sensitivity of the method is brought about by virtue of the fact that a hygrometric rather than a gravimetric measurement is made in establishing the permeability rate of a material. The report covering the development of this method includes (1) the development of a cryostat for the control of temperatures and relative humidities, (2) an investigation of the performance of the electric hygrometer at low temperatures, (3) the design and development of the permeability testing apparatus applicable to low-temperature work, (4) the evaluation of equilibrium relative humidities over saturated salt solutions, (5) the development of an indirect method for obtaining the moisture absorptive capacity of the electric hygrometer at both normal room and subfreezing temperatures, and (6) the development and performance of a small electric hygrometer, in which the moisture absorptive capacity is appreciably reduced. After the successful development of a small electric hygrometer having a low moisture absorptive capacity, permeability measurements were made at a temperature of 0°F. employing samples of Pliofilm and polythene. These measurements demonstrated that the dynamic test is a rapid method for evaluating the water-vapor permeability of moisture-proof materials having a low moisture absorptive capacity. Permeability rates of the order of 0.001 gram per (100 sq. in. × 24 hr.) were established within a period of 4 to 5 hr. after the specimens had been conditioned for a period of time sufficient to attain equilibrium conditions.

A *controlled relative humidity cabinet* for measuring water-vapor permeability or for determining the moisture equilibrium curves of pulp, paper, foods, etc. (*54*) is described. The important feature of this cabinet is that facilities are provided for weighing the specimens

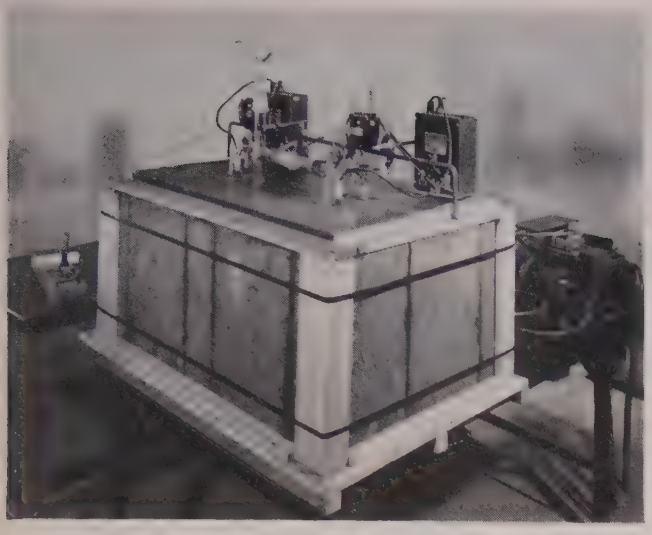

Fig. 20. Double cryostat for WVP testing

without removing them from the conditioned atmosphere within the cabinet. Details for the construction of a cabinet intended for operation at a temperature of 100°F. and a low relative humidity are presented and suggestions are made for the construction of controlled relative humidity cabinets at conditions other than the one mentioned. A brief discussion on the measurement of relative humidity is also included in this report.

An *electric sword hygrometer* for measuring the relative humidity of air inside packages or other enclosures (*50*) was developed under this program. The development of this instrument was undertaken to fill the need for an instrument which could be used either in the laboratory or in the field for measuring the state of dryness of air inside packages or cartons containing dehydrated foods or other materials which must be kept in a dry condition. The hygrometer is of the Dunmore type, covered with a protective coating to give it the ability to withstand frequent contact with hard, dehydrated particles of food or other materials. The hygrometer element is a structural part of a sword or a lance, which can be driven easily into a package. Approximately 2 or 3 minutes after piercing a package, an accurate determination of the relative humidity of the air inside the package can be made. The instrument indicates a current which, through the use of calibration charts, provides a measurement of the relative humidity. Details concerning the development of the method, the construction of the equipment, the calibration, and the operation of a portable instrument are given.

As a part of this program, considerable research work has been done on the *development of two new electric methods for the measurement of water-vapor permeability* (*53, 55*). These two methods have been designated the "*steady-state*" and "*dynamic*" methods. Both methods employ a small electric hygrometer and the permeability of a material is obtained through a hygrometric rather than a gravimetric measurement.

In the *steady-state method*, the test specimen is sealed between a space of constant, high relative humidity, and a narrow space of variable relative humidity. The latter space communicates with a large space (or room) of constant or known relative humidity through a variable, standard diffusion resistance. This resistance is varied to obtain a standard relative humidity in the narrow space between the specimen and the diffusion resistance. The relative humidity in the narrow space is indicated by a very small electric hygrometer. Under steady-state conditions, the water-vapor permeability is expressed in terms of the setting of the diffusion resistance.

In the *dynamic method*, the apparatus is modified by setting the diffusion resistance at infinity, or by replacing the partition containing the diffusion resistance with a glass plate. In using this method, the time rate of increase of the relative humidity in the narrow space is measured with the small electric hygrometer located in that space. The water-vapor permeability is obtained from the observed rate. Both theory and observations show that the rate depends upon the water-vapor absorption capacity of the portion of the specimen lying between the moistureproof barrier and the narrow space, as well as upon the steady-state water-vapor permeability. However, for a given type and grade of moistureproof sheet there is a correlation between the observed rate and the permeability as determined by the gravimetric method. Equations and charts have been developed for the direct conversion of the dynamic data to permeability values, which take into account the absorptive capacity of that portion of the specimen lying between the vapor barrier and the narrow space in which the hygrometer is located. This method results in the greatest speed of testing thus far achieved, and it is believed to be useful for mill control testing, in spite of the dependence of the results on moisture absorption characteristics of the specimen.

Moisture Content

A variety of instruments have been developed during

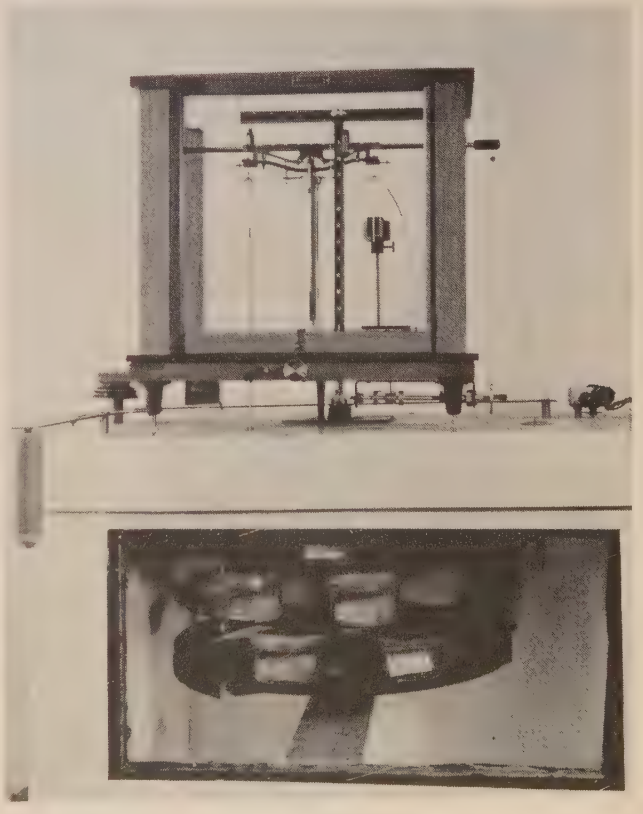

Fig. 21. Partial view of controlled relative humidity cabinet for WVP testing

the past several years for measuring the moisture content of paper. These are intended primarily for control purposes and were designed to give an instantaneous reading indicative of the moisture content; their action is largely dependent upon the electrical properties of the sheet, insofar as such properties are affected by the moisture content of the sheet. To check the reliability of instruments of this type, a study was made of the effect of the moisture content on the electrical properties of paper, and two commercial instruments, the *Hart Moisture Meter* and *the Moisture Register*, were evaluated (*71*). In this program, two laboratory resistance meters were constructed for evaluating the resistance-moisture properties of paper, and a rather thorough comparison was then made between the measurements made on a variety of papers at several moisture contents with these two instruments and with the Hart Moisture Meter and the Moisture Register.

The two laboratory instruments, which are described in detail, were a special direct-current vacuum-tube voltmeter designed to provide a constant potential across the sheet and an alternating-current bridge. The results obtained with the two laboratory models and the Hart Moisture Meter indicated that the a.c. and d.c. resistance values of paper at the higher moisture contents (those obtaining at relative humidities of 50% or greater) are in fair agreement, whereas those at the lower moisture contents show a departure in which the d.c. resistance values are ultimately many orders of magnitude higher than the a.c. values. All curves showing the resistance as a function of the moisture content exhibited a sharp break at moisture contents corresponding to a relative humidity of about 50%, thus indicating that the electrical resistance of paper apparently depends a great deal upon the mechanism by which the water molecules are bound to the fibers.

Comparative data are also given for papers exhibiting variations in fiber furnish, beating, pH, dyes, size, density, basis weight, and ash content. These results indicated that the instrumental readings of the Hart Moisture Meter and the Moisture Register are most seriously affected by fiber furnish. It is concluded that a separate calibration curve must be obtained for each grade of paper on which an instrument is to be used.

Another of the electrical instruments which has been evaluated under this program is the *Fielden Drimeter* (*71a*). This instrument utilizes an electrical capacitance method and is designed to measure the moisture content of a moving web of fabric or paper through the partial dependence of the dielectric constant of the combination of fiber and water on the moisture content. The moving web passes between two plates of a capacitor which forms one arm of an alternating current capacitance bridge, the off-balance signal of which is amplified and indicated on a meter.

Fig. 23. Hart Moisture Meter

The instrument and the method are described in detail, and a critical theoretical discussion is given of the application of a capacitance method to the indication and control of the moisture content of paper. It is shown that, although the dielectric constant of water is many times that of cellulose, the porous nature of paper and the smallness of the moisture content combine to result in a rather poor sensitivity. Moreover, despite the great sensitivity and accuracy obtainable with electrical methods, the method as employed in the Drimeter is quite insensitive because of the fact that nearly all the space between the test capacitor electrodes is air, whereas only a small fraction is occupied by the web. Calculations show that the expected changes in capacitance associated with ordinary changes in moisture content are extremely small, calling for an instrument of extremely great mechanical and electrical stability.

In the experimental examination of the Drimeter, tests made with 36 carefully prepared papers showed that there was only a general correlation between the moisture content of the paper and the Drimeter reading. In several instances, the Drimeter reading decreased when there was an appreciable increment in the moisture content, showing that the errors of the method, as employed, and of the instrument are much too large for the instrument to be regarded as satisfactory for the control of the moisture content of paper.

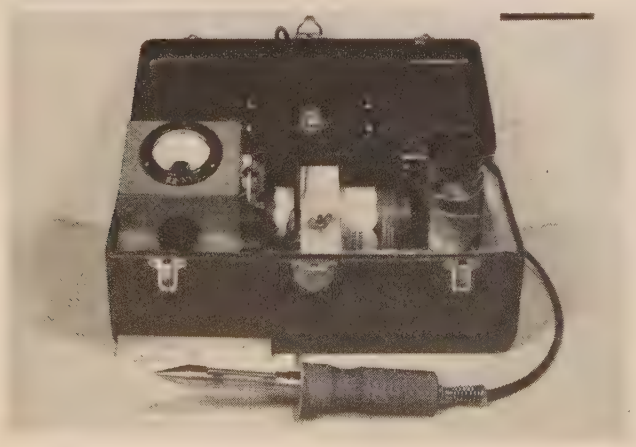

Fig. 22. Sword hygrometer

Compressibility

Compressibility is a property of interest in connection with the printability of paper. It is defined as the percentage decrease in caliper of the sheet produced by an arbitrarily specified increase in load. Compressibility is of interest in printing because of its effect upon the smoothness of the paper under printing pressures.

Fig. 24. Moisture Register

Some sheets, due to their composition and structure, are much more compressible than others. Thus, it is possible to have a situation in which the rougher of two sheets, when observed under no pressure, may be the smoother of the the two when under pressure and thus give the more uniform contact with the printing plate.

Compressibility may be calculated from caliper measurements upon a sheet at two pressures—viz., the lowest pressure at which reproducible caliper measurements can be obtained and at some considerably higher pressure. The compressibility so calculated is termed the *static compressibility*, since it is obtained for static loads. An objection is sometimes raised to this method because printing pressures are applied quickly and it is argued that compressibility should likewise be measured under a dynamic load.

The *Bekk hardness tester* (*29*) is an instrument intended to measure the dynamic compressibility of paper, as well as elasticity. This instrument is essentially a ballistic pendulum. The paper specimen is held against a hardened steel surface. The spherical face of the pendulum bob is coated with a thin layer of ink and the pendulum is allowed to fall from a fixed initial position and strike the paper, whereupon it rebounds and is caught before striking the sample a second time. The diameter of the inked impression left upon the sample is taken as a measure of the *dynamic compressibility* of the specimen.

A number of papers were tested with this instrument, and it was found that their ranking as regards compressibility was the same for any initial setting of the pendulum. The accuracy of the compressibility so measured is not discussed, as there is no other instrument available for measuring the dynamic compressibility of papers.

The static compressibilities of several papers were measured with the best micrometer caliper available at the time. The sensitivity of the caliper was not adequate but the static compressibilities of the papers fell in the same order as the dynamic compressibility measured with the Bekk hardness tester.

The Bekk hardness tester is also intended to measure the elasticity of paper. This elasticity is measured by the height of rebound of the pendulum expressed as a percentage of the initial height of fall. Previously published descriptions of the Bekk instrument indicate that there is some correlation between the elasticity and compressibility of paper measured with the instrument. This correlation was found to be poor. All printing papers are badly crushed at the point of impact, when the normal initial position of the pendulum is used. The initial height of the pendulum must be reduced to 20 or 30% of its normal value before papers of medium caliper survive the impact without crushing. It appears that, for the normal initial pendulum position, the observed elasticity of printing papers and papers of smaller caliper depends more upon the elasticity of the steel backing plate than upon the character of the paper itself. It is possibly due to this fact that the relative ranking of a set of samples is strongly influenced by the magnitude of the initial pendulum position.

It is concluded that the elasticity measured by the percentage rebound is not proportional to the dynamic compressibility and cannot be used as a measure of that property. It is suggested that printing papers be tested as single sheets and with the initial pendulum position not more than 25% of the normal values. Little can be said about the correlation of the property measured by this instrument and the printing quality of paper, as properly controlled printing tests were not possible.

The measurement of the compressibility of paper under static load was studied at a later time. In view of the previously mentioned inadequacy of the ordinary micrometer caliper gage, the Federal Products Corp. very kindly cooperated in the instrumentation program by designing and manufacturing two experimental models of a gage specially designed for the measurement of static compressibility.

These experimental models of the *Federal compressibility gage* (*39*, *40*) were designed to provide caliper measurements under pressures ranging from 6.6 to approximately 100 p.s.i. In the first model (*39*) the spindle of the gage flexes slightly as the load is increased and it is necessary to make correction for this flexing. With this correction it gives reproducible measurements of paper thickness under pressures up to 100 p.s.i. with a precision of ±0.00002 in. There are significant differences in compressibility between the different classes of paper and between some papers within a given class.

The second model (*40*) was designed in such a way that the flexing of the spindle found in the first model was reduced. The maximum correction for the first model is 0.00012 in., whereas that for the second model

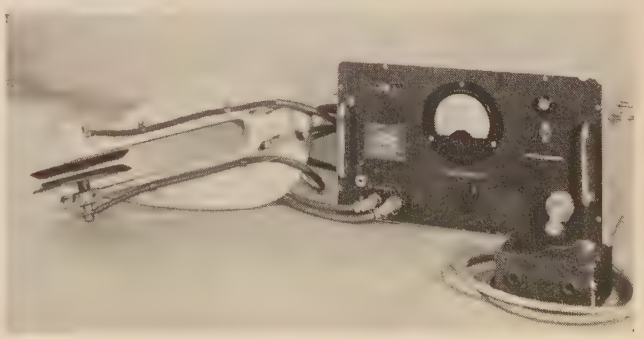

Fig. 25. Fielden Drimeter

is 0.00003 in. The second model is definitely superior to the first model for the measurement of the compressibility of hard papers. The failure of paper to completely recover from compression is illustrated for a number of papers. The scale of the second model is in error and, hence, actual thickness values are not correctly indicated. However, this fault has little influence on the evaluation of compressibility, since the results are expressed on a percentage basis.

Neither of these two models is entirely satisfactory for routine use in the mill. However, progress has been made and with the continued cooperation of the manufacturer, an instrument suitable for routine use may be available.

The *Gurley-Hill S-P-S tester* (*41*) is designed to measure softness as well as smoothness and porosity. The "softness" measurement is more closely related to compressibility than to the usual concept of what comprises softness, and the application of the instrument to "softness" measurement is discussed here rather than in the later discussion of softness and stiffness.

The softness measurement is carried out by a technique which somewhat resembles that used with the common smoothness testers. The specimen is punched and symmetrically placed between two plates. The lower plate is solid and its face is cut away to leave a raised annular ring which carries four symmetrically spaced plugs which project 0.002 in. above the surface of the annular ring. The upper plate has a smooth polished face with a hole in its center connecting to the air space under an inverted hollow piston floating freely in a cylinder partly filled with oil. The lower plate is pressed with a measured force against the specimen

Fig. 26. Federal compressibility gage

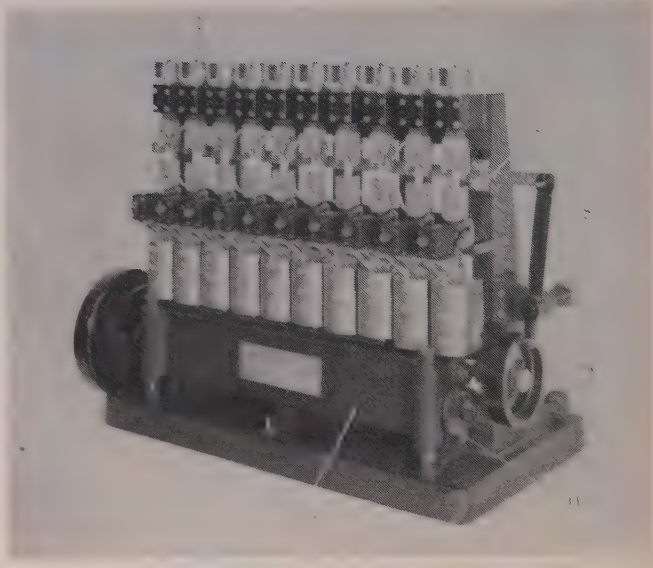

Fig. 27. Thwing multiple fold tester

backed by the upper plate, and the plugs sink into the specimen to an extent determined by the "softness" or compressibility of the specimen. The time required for a measured volume of air to flow out through the space between the annular ring of the lower plate and the lower surface of the specimen is the softness reading. This space is determined by the extent to which the plugs are pushed into the paper. This procedure is a very indirect measure of compressibility; it depends on the smoothness, lateral porosity, and thickness of the sheet, as well as on its compressibility. If the specimen is not smooth and flat, a second leakage path may exist between the upper plate and the upper surface of the specimen. This would constitute a serious source of error.

The correlation between these instrument readings and *direct* measurement of compressibility by means of the *Federal compressibility gage* for 33 papers is poor. Better correlation is not to be expected since the instruments differ greatly in principle. It is concluded that the S-P-S softness readings are a poor measure of compressibility.

Folding Endurance

All devices which have been developed for measuring the folding endurance of paper operate on the same general principle, and involve the application of both a bending and a tensile stress. In one test the specimen is folded double and creased by means of a heavy roller and the tensile strength in the direction perpendicular to the crease is then measured as a separate operation. In the more common methods, however, both tensile and folding stresses are applied simultaneously; the specimen is folded back and forth while under tension until failure occurs. In the Schopper folding strength tester, the total angle of bend is slightly less than 360° and the tension is not constant, but varies from less than 1 kg. at the neutral position to exactly 1 kg. at the point of maximum displacement. Tension is applied to the specimen by means of springs. In the M.I.T. folding strength tester, the total angle of bend is 270° and the tension applied to the specimen by a spring is 1 kg.

The *Schopper bending endurance tester* (*38*) is a varia-

Fig. 28. Thwing initial tear tester

tion from these two instruments in that both the angle of bend and the tension applied to the specimen may be independently varied. The instrument and the several variables in its operation are discussed. The folding endurance, which is measured in terms of the number of double bends the specimen will stand before breaking, decreases as the angle of bend is increased. An empirical relationship between folding endurance and angle of bend is indicated, the logarithm of the folding endurance being proportional to the angle of bend. This relationship is applicable to angles of bend lying between 60 and 180°. The bending endurance decreases as the tension applied to the specimen increases. For tests in the machine direction and for samples of medium or high endurance, the logarithm of the bending endurance appears to be proportional to the tension applied to the specimen.

Fourteen papers were tested with the *Schopper bending endurance tester*, using the maximum angle of bend—that is, a total angle of 180°—and with the *Schopper folding strength tester* and the *M.I.T. folding strength tester*. In all cases a tension of 1 kg. was used. Under these conditions the results of the Schopper bending endurance tester and the M.I.T. tester are in general of the same order, whereas those of the Schopper folding strength tester are appreciably higher. Due to occasional departures from these trends, however, further conclusions are unwarranted. The deviation between individual readings is high for all instruments and no one instrument appears to be superior in this respect. Apparently, specimen variation is the important factor.

An interesting departure from the common principle of these three instruments is shown by the *Thwing multiple fold tester* (*44*). This instrument also involves the application of folding and tensile stresses, but these stresses are applied alternately rather than simultaneously and the folding stress results from an actual crease rather than from a bending action around the edge of a metal jaw or the edge of a slotted metal plate. A further variation rests in the fact that ten specimens may be tested simultaneously; hence the adjective "multiple" in the name. The ten simultaneous tests are carried on by ten individual testing units, all driven by the same mechanism.

Differences in the physical dimensions and operating characteristics of the individual testing units indicate that the instrument is not made with the accuracy expected of a precision instrument.

As in the case of the Schopper bending endurance tester, it is found that there is an approximately linear relationship between the logarithm of the bending endurance and the tension applied to the strip. This relationship is best for papers of relatively high endurance and is not so satisfactory for the weaker papers. Tests made upon a rag content bond paper which was continuously stored in a constant temperature, constant humidity room indicate that the characteristics of the instrument change in the course of time. For example, tests on this paper at the beginning of the study of the instrument yielded a folding endurance of 608 single folds. After approximately seven months, during which time approximately 500,000 single folds were performed by each testing unit, the folding endurance of this same rag content bond was 300 single folds. Tests on "standard" papers carried out with the Schopper folding strength tester and the M.I.T. tester show that during this 7-mo. period those "standard" papers did not change appreciably and, hence, that the paper used in testing the Thwing instrument probably did not change either. It appears that the Thwing instrument must always be used with the same number of testing units operating, as the observed folding endurance depends upon the number of testing units simultaneously used. For example, when all ten were used, a sample was found to have a folding endurance of 160; when only two units were used, the folding endurance was found to be only 12. This variation is ascribed to variation in the tension applied to the specimen as the number of testing units is changed. This same variation in the effective tension applied to the specimen with number of units in use appears to explain the rather satisfactory agreement of the various testing units when used simultaneously; as each specimen breaks, the tension on the remaining specimens is progressively increased, thus speeding up their failure and tending to increase the apparent uniformity of the results. Cor-

Fig. 29. Elmendorf tearing tester

rection of the several mechanical defects and modification of the basic design of the instrument appear to be desirable.

Tearing Strength

A general discussion on the tearing strength of paper (*64*) is presented. This discussion covers a review of the published literature prior to 1943 and is concerned primarily with the theoretical aspects of the significance of tearing strength. A new theory is presented by means of which an analysis is made of the manner in which the energy expended in tearing a sheet is dissipated in the sheet. The principles embodied in the Elmendorf-Thwing and the Brecht-Imset instruments are discussed and consideration is given to the error arising from the various possible sources of the test.

Initial Tearing Strength

Tearing strength of paper is commonly evaluated by means of an instrument which measures the work required to continue, through a specified distance, a tear which has been started in one edge of the specimen. The *Thwing initial tear tester* (*43*) is designed to measure the force required to start a tear on the edge of a specimen. The reproducibility of the instrument readings is good. The scale of the instrument is rather arbitrarily divided and it is suggested that the calibration of the dial be changed to indicate actual pounds of force applied to the specimen. The instrument is not designed for use with light weight papers and this difficulty cannot be evaded by testing several strips simultaneously, since the observed initial tearing strengths are not proportional to the number of strips tested. It

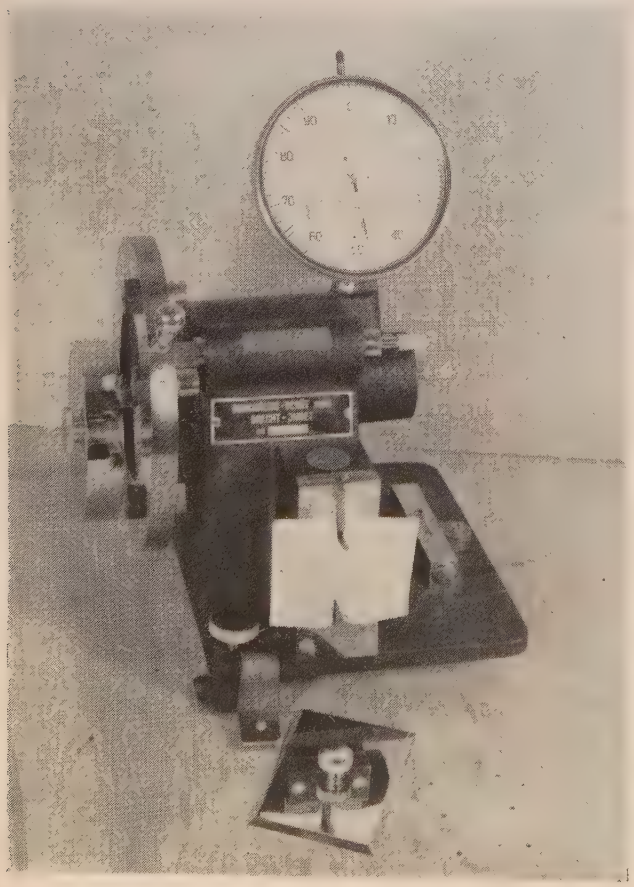

Fig. 30. Brecht-Imset through-tear tester

Fig. 31. Gurley R.D. stiffness tester

appears that initial tearing strength correlates in a general way with the *Elmendorf tearing strength*. Analysis of the stresses applied to the specimen, as well as experimental data, show that initial tearing strength, as measured by this instrument, is largely dependent upon tensile strength and stretch, the nature of the dependence being such that an increase in tensile strength and/or stretch causes an increase in initial tearing strength.

Continued Tearing Strength

The *Brecht-Imset through-tear tester* (*65*) investigated under this program is an instrument designed to measure the tearing strength of paper when the paper is subjected to a continuing tear. As in the Elmendorf method, the energy required to tear paper is measured by means of a compound pendulum; unlike the Elmendorf method, the measured tear follows an initial tear rather than an initial cut.

In a study of the instrumental constants and an investigation of the quality of agreement between the theoretical and the observed instrument indications, good agreement was observed for most, but not all, of the instrument's range. The instrument constant, by which the dial reading is multiplied to obtain the corresponding units of tearing strength, was found to be too large by 2%. Relative to the internal friction in the Elmendorf-Thwing tester, that observed in the Brecht-Imset instrument was found to be quite large, and variable.

Seventeen different types of papers were tested in a study of the tearing behavior of specimens torn in the Brecht-Imset and the Elmendorf-Thwing testers, and the data obtained were compared. In general, the quality of tear (as regards splitting of the paper) was somewhat superior in the specimens torn with the El-

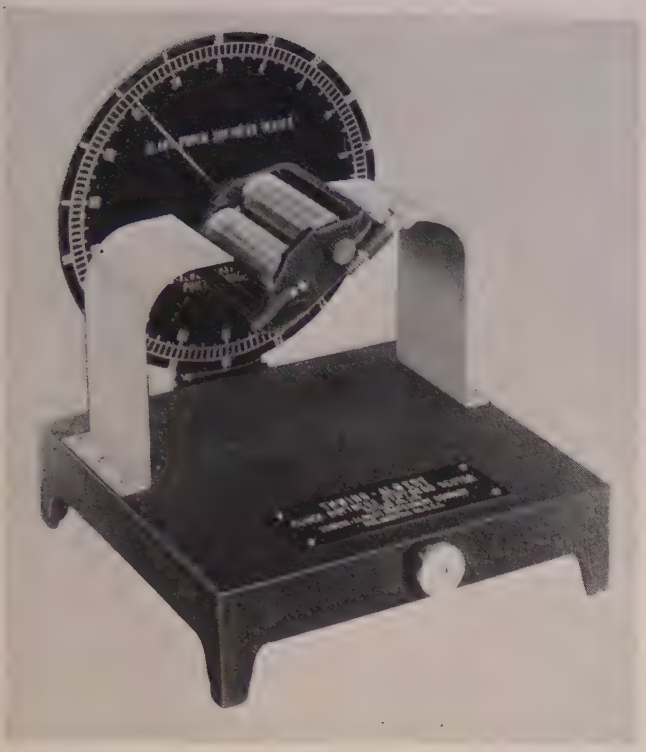

Fig. 32. Clark paper softness tester

mendorf tester. The advantages claimed for the Brecht-Imset mode of tearing were not confirmed. The testing of thin, lightweight papers with the Brecht-Imset tester was attended with considerable difficulty and, in many cases, a test could not be performed without considerable care on the part of the operator. Certain heavy papers were difficult to test, or could not be tested at all, because of the tendency of the tear to progress out to the side of the test specimen. Relatively little difficulty was encountered in the testing of writing, book, or other papers of ordinary weight.

The correlation between data obtained with the Brecht-Imset and the Elmendorf testers was found to be fairly good. The tearing force, when computed to a single sheet, tends to become constant when the number of specimens simultaneously torn is greater than two but is not excessively great. There is some indication that the two instruments would have been in better numerical agreement if it had been feasible, in all instances, to employ the same number of specimens in the simultaneous tearing in both instruments.

Stiffness and Softness

Stiffness and softness are two related properties which are important in a wide range of papers. The *stiffness* of a piece of paper is the property the sheet has of resisting bending. This property may be measured by determining the force required to produce a given deflection or by measuring the deflection produced by the given load when the paper specimen is rigidly supported at one end and the deflecting force applied at the free end. *Softness* may be one of several properties of a sheet of paper. In the case of tissues and toweling, softness is often used to indicate a combination of surface smoothness and limpness or lack of stiffness. For example, the sheet may be crumpled in the hand to yield a sensory estimate of softness. This estimate of softness is related to surface smoothness and limpness, as well as to the thickness of the sheet. On the other hand, softness is connected with the ease of folding and is an important use property of glassine and waxed papers employed as wrappers for such products as bread, cheese, soap, etc. In general, as the softness increases, the tendency of the sheet to pull apart any seals present in the wrapper decreases. However, when the softness becomes too pronounced, the wrapper does not hold its shape properly and loses much of its value in creating a pleasant psychological impression, as well as presenting difficulties in cutting and trimming.

The instrumentation program has included a study of four instruments for the measurement of stiffness and/or softness.

The *Carter stiffness tester*, the *Gurley stiffness tester*, and the *Smith-Taber stiffness tester* all make use of a deflecting force applied at some fixed distance from the clamped end of the specimen (*12*). The Gurley instrument may be used with a wider range of papers than either the Smith-Taber or the Carter instrument. The Gurley readings are affected by surface roughness or a poorly cut edge of the specimen. There is a fairly good correlation between readings of the Gurley and the Smith-Taber instruments; with both instruments the stiffness readings are found to be proportional to the width and inversely proportional to the square of the length of the specimen, providing it is greater than 2.5 in. With both instruments measurements on papers of low stiffness are facilitated by the use of multiple specimens, although it is recommended that not more than five be used. A factor is given which allows conversion of Gurley readings to Smith-Taber readings and vice versa. There is good correlation between the readings of the Gurley and the Carter instruments and, furthermore, the stiffness values are nearly proportional to each other. The Carter instrument is not satisfactory for very stiff paper because of the great deformation of the specimen which takes place, and because of the time required for attainment of equilibrium.

The *Clark paper softness tester* (*42*) differs from these three instruments in that stiffness is measured for a uniformly loaded specimen rather than for one to which a localized deflecting force is applied. With this instrument the experimentally observed quantity is a critical length; from this length four interrelated quantities are calculated—viz., "rigidity," "rigidity factor," "stiffness," and "softness." The correlation between *Gurley* and *Clark* stiffness values is fair and, hence, because of the correlation already noted, Clark stiffness values should show fair correlation with any of the other three instruments. The principle upon which the Clark stiffness values are obtained is found to be sound. This judgment is based upon the good agreement of the values of flexural rigidity, a quantity of significance in engineering practice, obtained with the Clark instrument and with a *torsion pendulum*. It was found that the Gurley instrument was seriously in error, particularly for papers of light and medium weight for which the error may be as high as 90% of the apparent stiffness value, because of the failure to take proper account of the specimen weight.

It is concluded that the Clark paper softness tester affords a more valid measure of the stiffness of paper than the other instruments currently available.

The Clark instrument was used to test the softness of a wide range of papers including glassines, waxed bread wrap, toweling, facial tissue, toilet tissue, wrapping tissue, cellophane, and manifold. The Clark softness values correlated fairly well with subjective estimates of softness for facial tissues, towels, glassines, and waxed papers.

The *Gurley-Hill S-P-S tester* (*41*) is designed to measure softness, as was noted earlier. The measurement, however, appears to have little, if any, connection with the common interpretation of the term softness which is under discussion. The measurement bears a closer relationship to compressibility. The S-P-S tester was, therefore, not compared with the instruments mentioned above, or otherwise evaluated as regards the measurement of softness.

Tensile Strength

The measurement of the tensile strength of paper and the factors which influence that measurement are discussed (*45*). It is noted that the tensile strength of paper is the tensile force required to rupture a specimen of stated width and length. Tensile testers are classified according to the method of loading the specimen—viz., pendulum, inclined plane, hydraulic, and spring type.

The calibration of these various types of tensile testers is considered, and it is particularly pointed out that the pendulum types of testers are properly calibrated by the so-called dead-weight method of loading. A known weight is hung from the upper clamp of the instrument, the pawls are held in the neutral position out of contact with the teeth of the quadrant, and the pendulum is allowed to reach an equilibrium position. The instrument is tapped to eliminate effects of friction and the scale reading noted. In this manner, the scale is checked at several points.

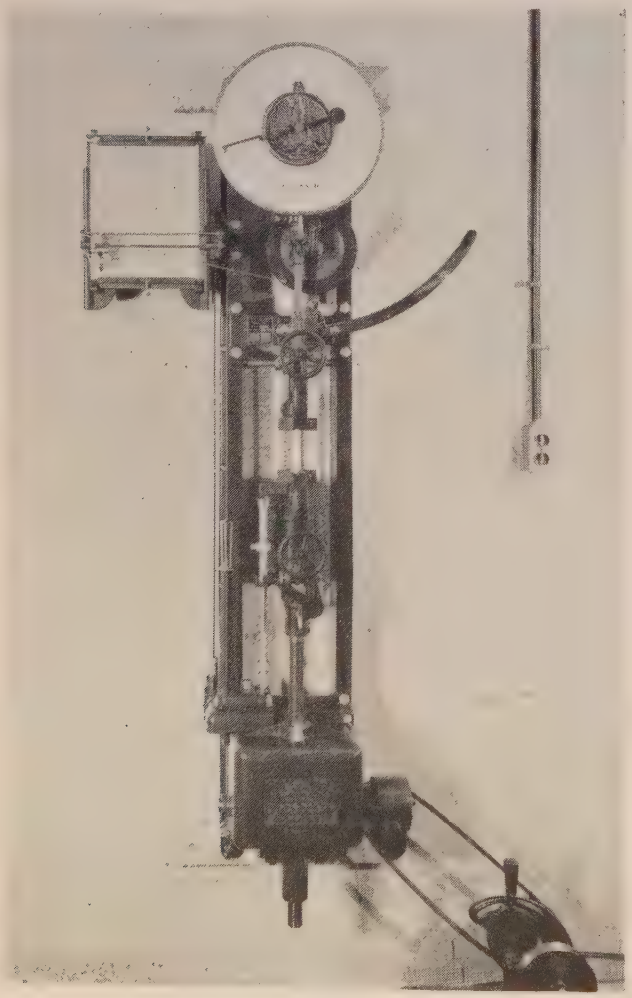

Fig. 33. Scott Serigraph

It is pointed out that the instrument should not be calibrated by letting the known weight ride down upon the lower jaw. When this is done, the momentum of the loaded pendulum as it passes or reaches the equilibrium point causes the pendulum to follow-through beyond the true reading and introduces a serious error, particularly at small loads and high clamp speeds; for example, in the case of a particular instrument, with a test load of 5.2 lb. and a clamp speed of 12 in. per min. the pendulum coasts beyond the true equilibrium reading by 10.6%. The calculated follow-through in the case of a test with an actual paper specimen shows that at a 5-lb. load and a clamp speed of 12 in. per min., the follow-through is not more than 3%. In general, the clamp speeds actually used in testing paper are such that the pendulum coasts beyond the true reading by a negligible amount, whereas in the case of the pendulum loaded with a test weight, the amount of coasting is not neglible for the same range of clamp speeds.

The several proposals regarding the proper rate of loading of specimens are reviewed and the tensile strength of each of six papers at six speeds, varying between 3 and 18 in. per min., is presented. The observed tensile strength increases with increasing rate of loading. For the six papers studied the increase in tensile strength varied from 6 to 11% for the range of loading used. The tensile strength observed according to the present TAPPI standard method, according to the method of constant time of test, and constant rate of loading, are presented and compared.

The dependence of observed tensile strength upon specimen length was examined for these same six papers and it was found that the tensile strength decreased by amounts varying from 4 to about 8% when the specimen length was changed from 2 to 8 in.

The dependence of tensile strength upon width of specimen is discussed from a theoretical point of view. It is argued that due to nonuniformity of the specimen and to the effect of the cut edges of the specimen, the tensile strength per unit width should be constant for large specimen widths but that, as the specimen width is decreased, the relative tensile strength should fall off quite rapidly. This argument is substantiated by experimental evidence for two papers. It happens that for these two papers the width at which the relative tensile strength begins to fall off from the value characteristic of wide specimens, is nearly the width which is now considered a standard—namely, 15 mm.

A *Scott tensile tester* (*46*) of the model called the Serigraph was studied. This instrument has two scales, 0 to 55 lb. and 0 to 110 lb., with the scales graduated in half pounds and pounds, respectively. The speed of the lower clamp may be continuously varied from 3 to 20 in. per min. The instrument is equipped with a recording mechanism for tracing load-elongation curves. The calibration of this particular instrument is not accurate. The 110-lb. scale is in error by amounts vary-

ing up to somewhat more than 1 lb., and the 55-lb. scale by amounts varying up to 0.7 lb. The major part of this error is due to inaccurate division of the scale. An undesirable amount of friction exists in the instrument; for the 55-lb. scale, the frictional force amounts to approximately 1.3 lb. For many applications to control testing these errors are not serious. For other applications they may be serious. Neither source of error is due to faults in fundamental design and both could be eliminated by the manufacturer.

The *Amthor universal tensile strength tester* (*47*) has three scales, 0 to 200 lb., 0 to 50 lb., and 0 to 15 lb., with graduation in pounds, quarter pounds, and tenth pounds, respectively. The calibration of each scale at three points by dead-weight loading indicates that the calibration is satisfactory. Examination of the accuracy with which the scales are divided showed that the accuracy is satisfactory through the lower part of each scale but that, in spite of the apparently satisfactory calibration shown by dead-weight loading, the upper part of the scales is not accurately divided. Friction is negligible in this instrument.

This particular instrument operates at only one speed —viz., a lower jaw speed of 12 in. per min. This speed corresponds to an average rate of loading of 2.5, 7.5, and 27.0 lb. per sec. on the 15, 50, and 200-lb. scales, respectively. In view of the current discussion of rates of loading as low as 1 lb. per sec., it seems desirable that the instrument be equipped with cone pulleys or a variable speed drive to permit change in the rate of loading from the present values. Apart from this lack of speed control, the instrument appears satisfactory for general use.

The particular *Schopper electrically driven strength tester* (*48*) which was examined has two ranges, 0 to 15 and 0 to 75 lb., with scales divided into $^1/_{32}$ and $^1/_4$ lb., respectively. The speed of the lower jaw is continuously variable from 2 to 20 in. per min. Calibration of each scale at a number of points by dead-weight loading shows that both scales are in error by about 1% at certain points in the lower part. Examination of the accuracy with which the scales are divided indicates that this error is probably due to inaccuracy of division. Frictional effects are entirely negligible in this instrument. This instrument is satisfactory for general use.

Stretch

The significance of stretch and of load-elongation curves and the investigation of four instruments used for the evaluation of stretch are discussed (*66*). The four instruments investigated were the *Amthor universal tensile strength tester*, the *Clark stretch tester*, the *Schopper electrically driven strength tester* and the *Scott Serigraph*. With the exception of the Scott instrument, these instruments are designed to measure the percentage elongation produced by a tensile force up to the instant of rupture. The Scott Serigraph is equipped with a recording mechanism for automatically tracing the load-elongation curve for the specimen. A comparison of the results obtained with these instruments and a critical examination of each of the stretch indicating mechanisms revealed the following.

The principle of the Scott Serigraph was found to be satisfactory; however, the particular model used in this study was of rather low sensitivity. The stretch-indicating mechanism of the Schopper instrument was dynamically unbalanced to such a degree that the indicator jumped to higher readings when the instrument was jarred by the failure of the specimen. This fault was temporarily minimized by counterbalancing. The Amthor and the counterbalanced Schopper instruments agreed fairly well but indicated stretches that were seriously high, as compared with values obtained with the Scott instrument. The reason for the discrepancy rests in the fact that both the Amthor and the Schopper instrument is so designed as to include in the indicated stretch reading some of the elongation which occurs after the start of the specimen failure. Stretch values obtained with the Clark instrument tend to be less than those obtained with the Amthor and Schopper instruments. The elongations measured with this instrument also include part of the failure elongation mentioned above, although a smaller part than those measured with the Amthor and Schopper testers. The Clark tester was not compared with the Scott instrument. Corroborating published results of other workers, it was

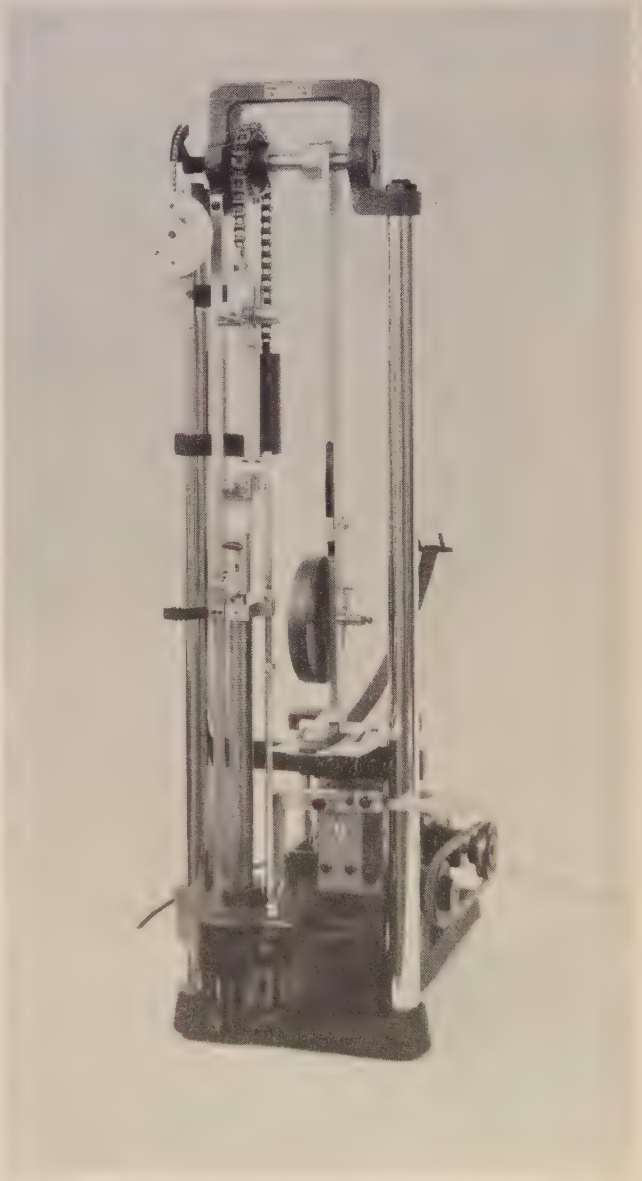

Fig. 34. Amthor universal tensile strength tester

found that percentage stretch decreased as the length of the specimen decreases. Contrary to suggestions in the literature, tests with two papers showed no change in stretch with change in rate of loading and showed that stretch tends to increase with increase in specimen width.

Puncture

Boxboard containers used for shipments must be capable of withstanding severe and rough handling. By way of controlling the performance of finished containers, numerous tests have been devised for the evaluation of the physical properties of the boxboard itself and for the evaluation of finished containers with regard to their resistance to mechanical handling. An instrument, investigated under this program, which falls in the category of those instruments developed for the evaluation of finished containers is the *Beach puncture tester* (*68*). The more recent models are known as the General Electric puncture tester. This instrument was designed for measuring the ability of a container to withstand puncturing blows by measuring the work required to pierce a paperboard with a pointed, but blunt, pyramidal head. The instrument is of the pendulum type employing the principle of measurement used in the Elmendorf tearing strength tester. Upon release, the pendulum swings freely until the puncture head meets the specimen, and the puncture occurs. A sliding friction pointer indicates the units of energy expended in puncturing the specimen. The scale has four ranges made possible by the addition of weights to the pendulum. This investigation was concerned primarily with the principles of the method and design and no attempts were made to correlate the instrumental readings with the subsequent performance of containers.

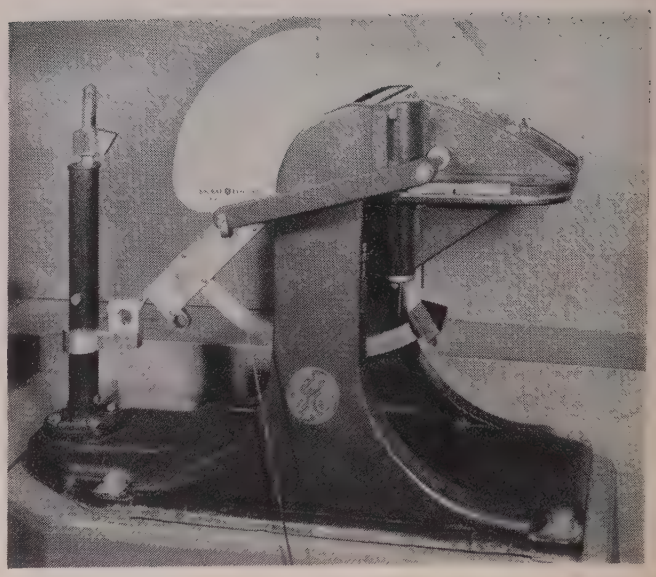

Fig. 36. General Electric puncture tester

Fundamental measurements made upon the instrumental constants and scales showed the latter to be accurate. Frictional losses were found to be small and of such nature as to be allowed for, with one exception: an appreciable loss occurred because of the method of mounting the auxiliary weights. A significant error was found in the displacement of the release mechanism when the auxiliary weights were added to the pendulum system. Strain-energy set up in the puncture arm was found to result in appreciable error. The effect of sharpness of the edges and point of the puncturing head was investigated for a number of boards, and a consistent relationship between test results and sharpness was not found; this led to the conclusion that, whatever the ultimate significance of the instrumental reading, a difference between a pair of readings on different boards is not significant if less than several per cent. The influence on test results of thin films of tacky and lubricating materials was measured, and it was found that the nature of the surface of a specimen could, under certain conditions, affect the puncture work quite materially; doubt is expressed that differences of this origin reflect the relative abilities of two boards to withstand a puncturing force. The effect of varying the size and angular orientation of the triangular sample aperture was observed with the view of establishing manufacturing tolerances on these variables. Several suggestions for the improvement of the instrument are presented.

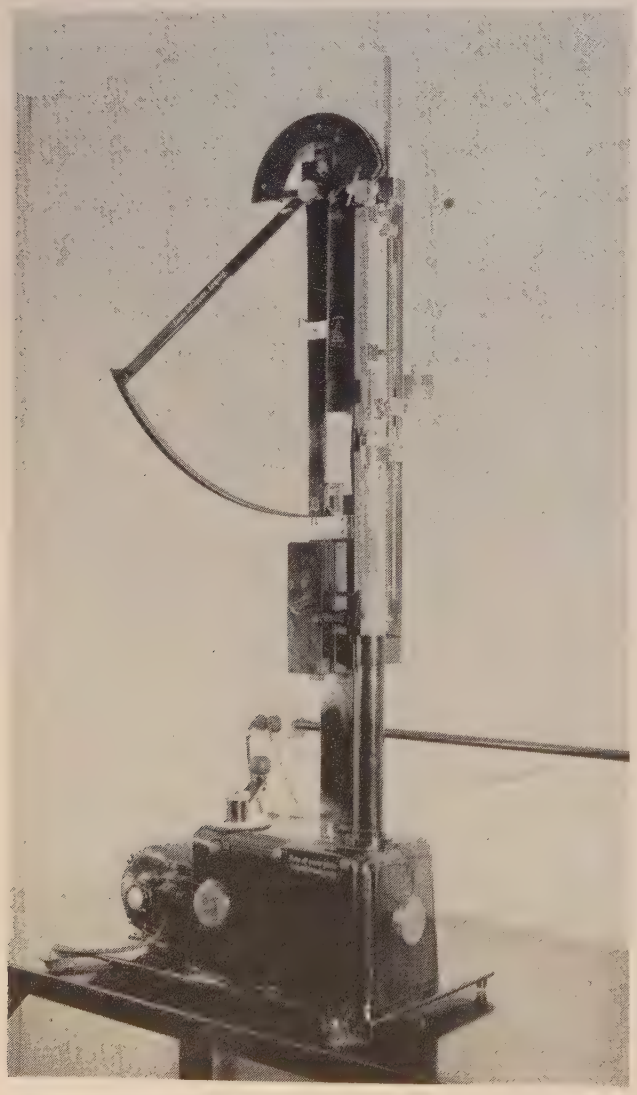

Fig. 35. Schopper electrically driven tensile strength tester

Air Permeability and Porosity

The *air permeability* of a sheet of paper is its property of allowing air to pass through it when a pressure difference exists across the sheet. It is commonly evaluated

by observing the time required for a measured volume of air to flow through a specimen of stated dimensions under standard conditions. The ability of a package to "breathe" depends upon the air permeability of the paper. Air permeability and porosity are often used synonymously, although a useful distinction exists. *Porosity* is the property a substance has of containing connected air voids. It depends on the number of the voids and their distribution in size, shape, and orientation. Air permeability is a common measure of porosity.

The *Gurley-Hill S-P-S tester* (*41*) is designed to measure porosity and air permeability, as well as smoothness and softness. The measurement consists in observing the time required for a measured volume of air to flow through a specimen of fixed area under standard pressure differences. Tests in which the edges of the specimen were sealed by a special procedure indicate that under the normal conditions of use the porosity values for rough papers are too low because of air leakage past the normal seal. A comparison of porosity values obtained with this instrument and the older type *Gurley densometer* shows the correlation to be good. The newer instrument has a superior clamping arrangement.

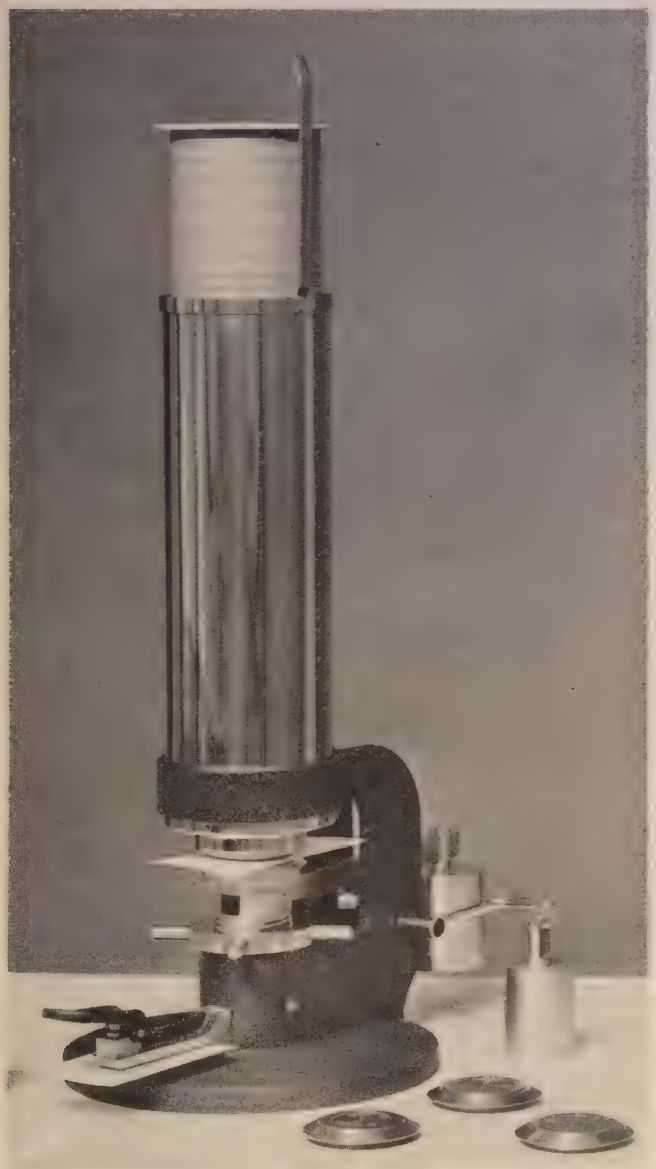

Fig. 37. Gurley-Hill S-P-S tester

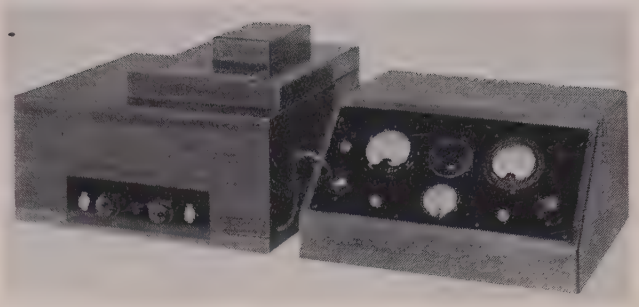

Fig. 38. Thwing formation tester

Formation

Formation is a property which is determined by the degree of uniformity of distribution of the solid components of the sheet, with special reference to the fibers. It is usually judged by the visual appearance of the sheet when viewed by transmitted light. This property is important, not only because of its influence on the appearance of the sheet but also because it influences the values and uniformity of values of many other properties of the sheet.

The *Thwing formation tester* (*2, 3*) was one of the first instruments studied on the instrumentation program. The instrumental measurement and visual judgment of formation are discussed in these two reports. The Thwing formation tester and its operation are described. The instrument measures the fluctuations in intensity of the light transmitted by the sheet as the sheet is rotated in a beam of light. The reproducibility of instrument readings is shown to be good. The instrument measures the same property as that graded by visual judgment and the correlation between instrument reading and visual ranking by a group of trained observers is satisfactory. The reproducibility of visual ranking by different observers is shown to be relatively poor and the agreement between the Thwing instrument results and the average of the visual rankings is much better than the agreement between the individual visual rankings.

Caliper

The *Pratt and Whitney Electrolimit gage* (*67*) studied under this program is a device which may be attached at the dry end of a paper machine to indicate and record the instantaneous thickness of the moving paper web. Its operation is based on the fact that the inductance of coils wound around an iron core will change when an air gap in the core is changed in thickness. Part of the magnetic circuit is the iron or steel cylinder around which the paper passes and on which the gage rides. The gap referred to is that between the cylinder and the pole faces of the gage; when the paper thickness increases or decreases, the rollers of the gage are raised or lowered and, correspondingly, the air gap is increased or decreased. In this way the device indicates and records deviations from the normal caliper.

On the basis of theory, the difference between the indicated caliper and thickness as determined by standard laboratory methods will depend upon the surface con-

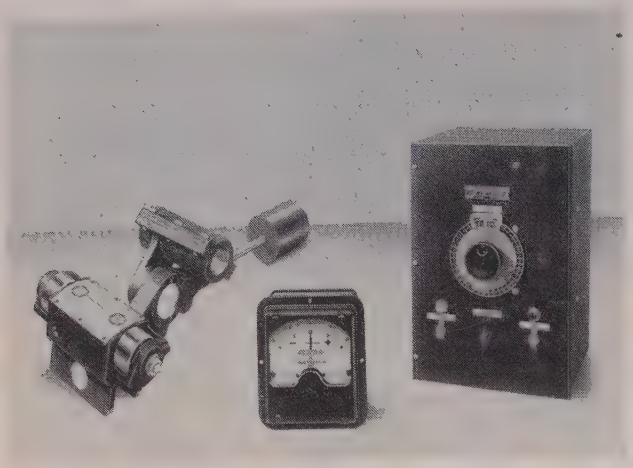

Fig. 39. Pratt & Whitney Electrolimit thickness gage

tour, formation, and compressibility of the paper, and upon machine vibration. Actual experiments have shown, however, that proper location, mounting, and loading of the device satisfactorily minimize discrepancies resulting from the foregoing causes. All the components of the device were found to be sufficiently stable to maintain a satisfactory state of calibration for long periods of time. The accuracy of the device is not impaired by variations in the composition of the paper (except as composition may influence compressibility), moisture content, or line voltage (within a limited range of variation).

Fuzz

A sensitive means of measuring the light scattering of turbid solutions, smoke, dust, and the fuzz of paper was described (*18*). The light from an effectively point source is rendered parallel by a lens and passes through the region in which the scattering particles are placed. This parallel beam is focused by a second lens at a diaphragm so that no unscattered light reaches the eye or photocell placed behind this small diaphragm. When scattering particles are placed in the parallel beam, the scattered light is collected by the second lens and passes around the small diaphragm to the eye or measuring photocell. The special arrangement for the measurement of fuzz on paper is described in detail. The instrument is not suitable for routine use in a mill but is a very sensitive device for special applications in the laboratory.

Smoothness

The smoothness characteristics of printing papers were discussed and a description of the first stage in the development of an instrument to measure printing smoothness was presented (*6*). It is pointed out that, for each type of printing, there is probably a type of paper with optimum finish. The surface requirements of printing papers are nearly as varied as the uses to which they may be put. It is recalled that a number of paper qualities not normally associated with smoothness play fundamental roles in printing as though they were due to smoothness. Among these qualities are formation and compressibility. A smooth sheet may print poorly because of poor formation, whereas a rough sheet may print as well as a smooth sheet as a result of its high compressibility, which makes the paper smooth under the printing pressure.

These smoothness characteristics are discussed in terms of the typical surface defects of uncoated papers, defects due to the coating process, and defects due to the uncoated sheet and the coating.

The first stage in the development of the *Davis smoothness tester* is described. This instrument makes use of the principle of total internal reflection of light. If a glass prism of proper angle is suitably truncated with top and bottom faces parallel, and light falls perpendicularly upon one of the sides of the prism, the light which passes into the prism is reflected from top to bottom in a zig-zag path until it emerges from the opposite side of the prism. No light passes through the top or bottom at each reflection because the angles are so chosen that total internal reflection takes place. If a sheet of paper is placed against either the top or bottom of the prism, some of the fibers in the sheet make good optical contact with the surface of the prism and light which strikes the prism at that point is no longer totally reflected, but passes through the surface into the fiber and, hence, is lost from the beam which passes through the prism to the opposite face. If the pressure against the sheet of paper is increased, a greater proportion of the surface makes good optical contact with the face of the prism, more light is lost at each reflection and the beam passing through the prism is still further reduced in intensity. Thus, the intensity of the beam passing completely through the prism may be a measure of the smoothness of the sheet of paper in contact with the face of the prism.

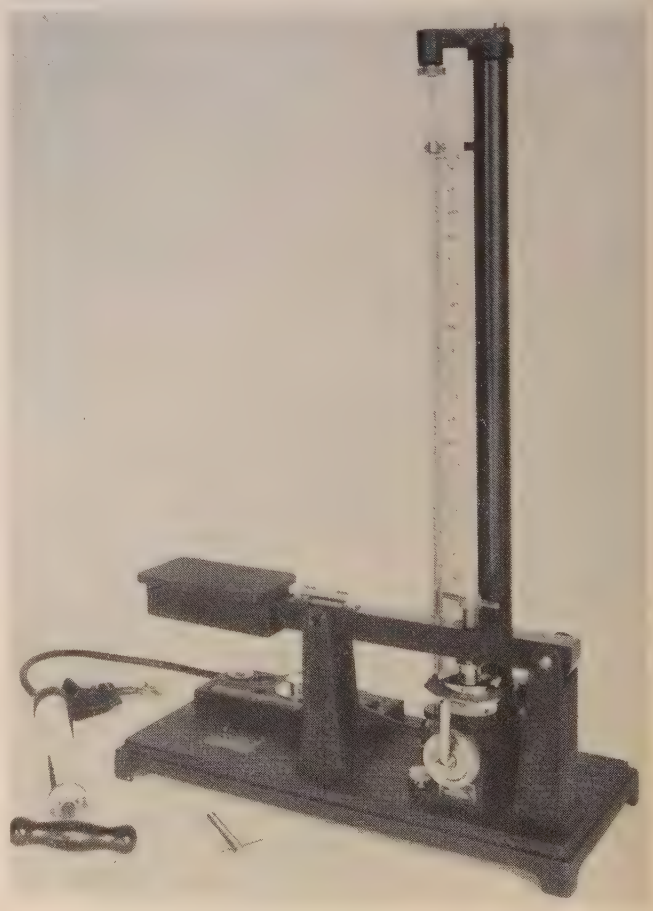

Fig. 40. Bekk smoothness tester

The experimental model of an instrument embodying this principle is described in detail. The results of tests upon four groups of papers are presented. The first two groups were visually ranked by a committee of papermakers. The third group was chosen because it represented a striking case in which the visual smoothness was quite different but in which the instrumental smoothness was the same. The fourth group compared instrument readings with actual printing results.

The conclusions are: The correlation between instrument readings and visual grading of the papers is very poor. The instrument does not distinguish between samples taken at various stages in the manufacturing process between the suction couch and the supercalender reel. The correlation between instrument readings and actual printing tests is good, except in the cases where formation is a predominating factor.

The *Bekk smoothness and porosity tester* and the *Gurley R.D. smoothness and porosity tester* are described and compared (*13*). These instruments make use of the same general principle. Briefly, this principle is as follows: The volume and thickness of the air void between a plane polished surface and a paper surface is related to the smoothness of the paper. If the paper is rough, the effective thickness of this leakage space is greater than for a smooth paper. The rate of air flow between the two surfaces under a given pressure differential is related to the effective thickness of the void. The time required for a given volume of air to flow through this space under a standard pressure difference is taken as the smoothness value. The assumption is made that, by adjusting the pressure between the surfaces, the condition of the paper surface can be made to correspond approximately to its condition in the printing press.

The theory of the method and the factors which affect each measurement are discussed. In the Bekk tester the sample of paper is pressed against a polished glass plate having a hole in its center, and air leaks from the edge of the sample through the boundary between paper and glass plate to this center hole. Either wire or felt side of the sample may be tested. In the Gurley instrument, the sample is clamped between two highly polished metal surfaces, each bearing an annular slit. Smoothness is measured by determining the time required for a given volume of air to escape between the flat metal surface and the paper surface. Independent measurements may be made on both sides of the specimen at the same time.

In general, the correlation of *Bekk* and *Gurley* smoothness values is poor. The variation between individual readings is greater for the Gurley than for the Bekk instrument.

The *Williams smoothness and formation tester* (*31*) employs the same principle as the Bekk and Gurley instruments except that two paper surfaces are pressed against each other instead of one paper surface. The back side of each sheet is in contact with a soft rubber gasket which theoretically seals these back surfaces. Holes are punched in the samples and the smoothness measurement consists in observing the time for a fixed volume of air to escape between the paper surfaces. In this instrument provision is made also for the measurement of transverse porosity—i.e., the air permeability in the sheet direction. The smoothness of either wire or felt side may be obtained by proper choice of the surfaces of the paper which are put together. Only in the Williams tester is transverse porosity recognized and an effort made to correct for it. There is a rough correlation between the *Bekk smoothness* and *Williams smoothness* uncorrected for transverse porosity.

The *Gurley-Hill S-P-S tester* (*41*) employs the same principle as the other three instruments. Eight thicknesses of paper are punched and held between an upper orifice plate and a solid lower plate, having a plain annular ring. The smoothness measurement consists in measuring the time for a given volume of air to escape between the several paper-to-paper interfaces. This test does not distinguish between wire and felt sides of the paper. The variations between individual readings is less for the S-P-S tester than for any of the other instruments. This test is called the "rapid smoothness test" and it seems properly named, for the simultaneous testing of eight sheets provides better sampling than the other tests and, hence, yields a useful average value with fewer operations. The *Gurley-Hill S-P-S tester* shows good correlation with the *Bekk* instrument, fair correlation with the *Gurley* at low smoothness values, and poor correlation with the *Gurley* at high smoothness values.

It is pointed out that none of these instruments measure a single fundamental property. The results are influenced by several properties and instrumental characteristics. The value of any instrument lies in its ability to evaluate a paper for a specific use requirement or to act as a control instrument for a manufacturing operation. No one instrument can be used as a criterion of the value of another until extensive data are available which show that the test values of some one instrument correlate well with some fundamental or use property of paper.

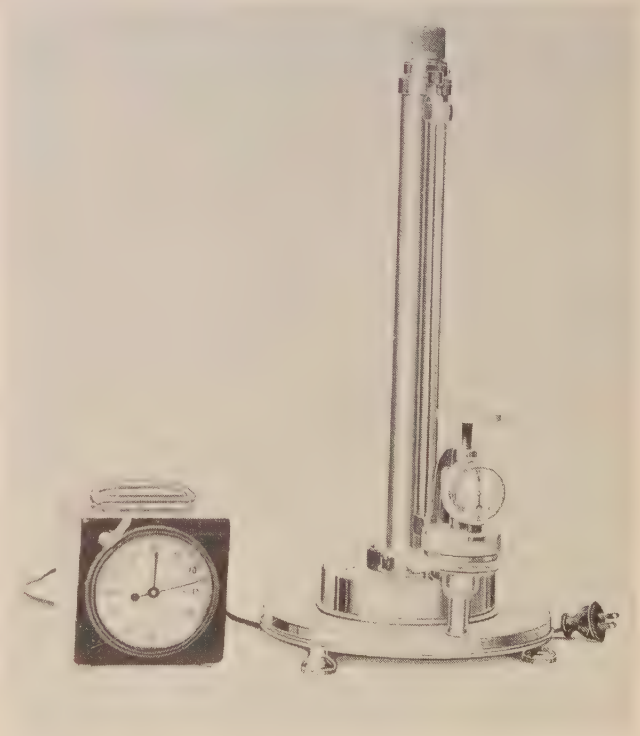

Fig. 41. Williams electric smoothness and formation tester

Several quite different methods of measuring smoothness were considered (*13*). This discussion differentiates between the smoothness of a free surface—i.e., a surface under no pressure—and the smoothness of a surface under pressure. The first type of smoothness is probably that evaluated by visual judgment; the second type is that which is effective in printing.

The methods for measuring the smoothness of a compressed surface are those already discussed.

The methods for measuring the smoothness of a free surface are: topographic mapping of a surface by means of a microscope, or by means of a small rider under which the paper surface is caused to move and recording of the rider position by optical means; the electrical pickup method, in which the needle of an electrical phonograph pickup moves over the paper surface and smoothness is evaluated in terms of the amplified response of the pickup; frictional methods in which the coefficient of friction between paper surfaces or between paper and a standard surface are measured; an optical method depending upon the difference in apparent reflectance of a surface when the incident light strikes it at a very small angle and when it strikes at a larger angle; an electrical capacitance method in which the paper sample forms the dielectric, first in a condenser formed by two parallel plates and, second, in a condenser formed by one plate and a pool of mercury, and in which the smoothnesses are measured in terms of the difference in capacitance for these two arrangements. This last method is discussed in some detail and experimental results are presented. There is no correlation with *Bekk* or *Gurley* smoothness or with *visual ranking* of smoothness.

Surface Bonding Strength

The development of methods for evaluating the mechanical properties of paper has been most progressive along the line of the use requirements which involve rupture, distortion, or bending along or about a cross section of the sheet. Until recently, less attention has been paid to the failure of paper along a plane within the sheet and parallel with its surface. The resistance of paper to removal of coating or fibers or to cleavage parallel to the sheet direction is termed "bonding strength" or "surface bonding strength." It should be distinguished from ply adhesion or the resistance to splitting of two plies of a laminated sheet. Surface bonding strength is of importance in considering the picking of fibers and coating by tacky inks during a printing operation and the cracking of the coating of coated paper during folding or creasing operations.

Existing methods of measuring surface bonding strength were reviewed and studied (*57*). Among these methods are: the *Dennison wax test*, the *Bekk surface tensile test*, the application of *conventional tensile testers* to the measurement of the force required to rupture a sheet cemented between two blocks when the blocks are pulled apart by the jaws of the tensile tester, a special application of the *Elmendorf tear tester*, and a "*Scotch tape test.*"

It is concluded in this study that the interpretation of the results of all the tests mentioned is doubtful and that none of the methods is entirely satisfactory from either a theoretical or a practical standpoint.

In a further study of the *Dennison wax test* (*58*), the effects of the heating and cooling rates on the behavior of the test were determined and the correlation between the Dennison critical wax number and the rupturing force were obtained by techniques developed for the purpose. The studies were made with two series of commercial coated papers prepared in a special mill run in which the only variables permitted were the nature of the base stock and the ratio of adhesive to pigment. Under these carefully chosen conditions, a fair correlation between critical wax number and rupturing force could be demonstrated. However, the observations of this and the previous investigation showed that the test requires interpretation by one who has had considerable experience with its behavior. Without a knowledge of its limitations when applied to samples selected at random, misleading conclusions will frequently be drawn; in the hands of an expert who follows the latest recommendations of the manufacturer as regards interpretation, the test can be of value.

The various methods for the measurement of the strength of the bond between the surface and the body of a sheet are subject to errors such as those originating in penetration of the sheet structure by the adhesive, modification of the sheet by elevated temperatures where the adhesive requires heating, and strongly varying stress due to uniform thickness of paper.

The *development and investigation of a new method for evaluating the surface bonding strength of paper* (*59*) was undertaken with the objective of overcoming these difficulties. In this method, a tensile stress is applied to the surface of the paper by means of a viscous film in a manner simulating the actual printing operation in a cylinder press. The apparatus, which is described in detail, consists essentially of a pair of steel wheels or rollers having finely ground surfaces which carry films of known and constant thickness of a viscous oil of known viscosity. These wheels are caused to roll over test specimens under a known load with uniform but continuously variable speed. The speed of the wheels, which is accurately measured by means of an electric speed meter, is varied until that speed at which rupture occurs is determined. Description of techniques and such auxiliary equipment as the viscometer, film-forming devices, and speed meter are given.

The critical speed is defined as that above which the test specimen suffers an open rupture. At speeds slightly below critical, coated papers exhibit a "blistering," which is due to internal failure. As the speed is increased to the critical speed, the blisters become more extensive and open up, small bits of the surface adhering to the surfaces of the wheels. At speeds appreciably greater than the critical speed, the rupture is complete and general, large areas being carried away by the wheels. Investigation of the relationship between critical speed and viscosity for constant bonding strength shows that, within experimental error, the product (viscosity) $\times$ (velocity) = constant. This is taken as a measure of bonding strength. In a special series of samples in which the casein content of the coatings varied from 10 to 22%, the viscosity velocity product (VVP) varied from about 12 to 95 kp.-cm. per sec.

Erasability

The erasability of paper is a property that cannot be

evaluated in the sense that an instrumental number can be obtained which is accurately descriptive of the erasing quality of the paper. In the past the erasing quality of paper has been judged subjectively through erasure performed by hand, with various kinds of erasers, and a number of factors have been involved in the judgment. These factors include the ease or difficulty of removing written characters from the paper, the appearance of the erased area, and the writing quality of the erased surface after one or more erasures. It is not surprising, therefore, than an instrument for testing erasability which would generally be considered satisfactory has not been created. Nor will it be possible for such an instrument to be developed before a clear, generally accepted definition of this property has been evolved.

As the first step in the initiation of research on this subject, several technical persons in the writing paper industry were asked to give their definitions of erasability. These definitions, together with a general discussion of erasability, are given in a report (*72*). The various factors which are called into play in a judgment of erasing quality are enumerated and discussed, with particular reference to the probable success or failure of control or measurement of the factors. It is concluded that a concise, yet adequately specific, definition of erasability is not to be expected. The phenomena of erasure should be studied with research equipment, and such a study may form the basis for a later, detailed definition of erasability.

In conformity with this thought, research equipment was designed and constructed and many of the factors relating to the subject of erasure were investigated (*73, 74*). An abrading machine is described with which it is possible to erase a surface of sufficient area to permit a subsequent evaluation of the changes in the physical properties of the paper caused by erasure. Data on the erasing characteristics of 29 different samples of paper are given, showing the effects of erasure on weight loss, reflectance (R_∞ and R_o), gloss, and writing quality. Other factors investigated include a study of (1) the performance and uniformity of 21 "Calibrase" abrading wheels, (2) the abrading rates as the erasure proceeded from the surface of the paper into the body of the sheet, (3) the effect of speed of the abrading stroke, (4) the effect of vertical thrust of the abrading wheel on the paper, (5) the effect of repeated erasures on erasability data, (6) the effect of ink composition, and (7) the effect of relative humidity. A summary and discussion of thirteen factors pertinent to the erasability of paper are given. Coincident with the study of the foregoing variables, an interesting phenomenon concerning the inherent structure of paper was discovered. Strong directional effects were apparent in the erasure of some papers which are attributed to a "shingled" effect of the fibers in the sheet (the directional effects are those associated with the change from machine to antimachine direction of erasure—not from machine to cross-machine direction).

A proposed method for evaluating the erasing quality of paper, as derived from the foregoing studies, is given in a report (*74a*). This procedure represents an objective approach to the evaluation of erasability and places emphasis on three general aspects of the problem —namely, (1) ease of erasure, (2) the appearance of the erased surface and that of the rewritten characters, and (3) the function of the paper.

Adhesion and Cohesion

The timely interest in the measurement of strength of bonds has warranted the inclusion in this program of a general discussion of the measurement of adhesion and cohesion (*70*). In addition to the ever-important problems of evaluating the internal, transverse bonding strength of paper and the strength of bond between surface coatings and the base stock, the development of paper-base laminates has introduced new combinations of paper and metals, paper and wood (plywood), plastics, and other materials. Improvements in the "welding" of these new combinations will depend in part on the evolution of satisfactory methods for the evaluation of adhesion. Greatly increased research and developmental work on containers has called for new and improved methods for measuring ply-adhesion, strength of bond between liners and corrugating medium, wet strength of bonds, scuffing resistance of paperboard surfaces, and evaluation of the "tackiness" or adhesiveness of waxes and other materials employed in the heat sealing of containers.

This discussion gives a review of existing methods for evaluating adhesion and bonding strength and presents a critical consideration of the stresses involved in the measurement of strength of bond in tension, compression, shear, torsion, and in special tests. The manner in which various factors can result in stress intensification and failure at spuriously low apparent stress is described in some detail. Suggestions for the improvement of instrumentation of adhesion measurement are given. The discussion concludes with a section on the influence of factors relative to use requirements.

Equilibrium Relative Humidities Above Saturated Salt Solutions

The use of saturated salt solutions as a means of providing constant relative humidity in an enclosed space has found increased applications, many of which require the conditioning of an atmosphere to a definite relative humidity as well as to a given temperature. In testing procedures where a wide range of humidities is required, such as the determination of sorption isotherms of foods or cellulosic products, the determination of water-vapor permeability, or the determination of hygroexpansivity of papers and other sheet materials, saturated solutions are particularly useful for providing a constant relative humidity. Handbook tables of solutions for maintaining constant relative humidities have, as a rule, been found to be inadequate. The relative humidities for most salt solutions are dependent upon temperature and it has too frequently been found that the values quoted are for temperatures other than those required for most purposes. Moreover, work relating to conditioning problems has shown that a few of the handbook values are seriously in error. In order to examine these discrepancies and to obtain more complete data, the equilibrium relative humidities above saturated salt solutions at various temperatures were evaluated under this program (*69*).

The procedure employed to establish the equilibrium relative humidities involved a measurement of the vapor pressure of the solution, which is a measurement of a

fundamental quantity in the concept of relative humidity. The relative humidity is defined as the ratio of the actual water-vapor pressure in any space to the pressure of saturated water vapor at the same temperature.

The report covering this work describes the vapor pressure apparatus and the method of measurement, and presents new data for seventeen saturated salt solutions that may be employed for maintaining a constant relative humidity in essentially moisture-tight enclosures. The equilibrium relative humidity and the vapor pressure of saturated solutions are given for three temperatures—namely, 73, 86, and 100°F. Charts are also presented, giving the relative humidity as a function of temperature.

Dirt in Paper

A critical discussion of the published methods for evaluating "dirt" in paper is presented in a report (*75a*). In this discussion, it is pointed out that the present methods are very inadequate and that individuals are often called upon to make visual evaluations of a highly subjective nature. Because of the personal element, the reproducibility for an observer or between different observers is not very good, even when the latter were trained in the same laboratory. Variations of the order of 10% have been reported for a single observer and of the order of 20% for two observers.

Because of the difficulties inherent in the visual methods and because of the need for further work on this subject, it is suggested that a thoroughgoing study be made of the psychophysical factors involved in the "noticeability" and "visibility" of objects. In addition, it is suggested that experimental work of an objective nature be done on the noticeability and visibility of actual specks in paper.

LIST OF INSTRUMENTATION REPORTS

1. Instrumentation program. Nov. 20, 1935. Instrumentation Studies I. *Paper Trade J.* 103, No. 25: 38–43 (Dec. 17, 1936).
2. Report No. 1 to A.P.P.A. The evaluation of formation by the Thwing formation tester. Jan. 10, 1935. Instrumentation Studies III. *Paper Trade J.* 103, No. 27: 29–31 (Dec. 31, 1936).
3. Report No. 2 to A.P.P.A. Correlation of Thwing formation readings to visual formation gradings by the Mead standards. May 6, 1935. Instrumentation Studies IV. *Paper Trade J.* 104, No. 1: 39–41 (Jan. 7, 1937).
4. Report No. 3 to A.P.P.A. Report on gloss. Nov. 20, 1934. Instrumentation Studies V. *Paper Trade J.* 104, No. 1: 42–45 (Jan. 7, 1937).
5. Report No. 4 to A.P.P.A. Report on the modified Oxford glarimeter. Jan. 10, 1935. Instrumentation Studies VI. *Paper Trade J.* 104, No. 2: 42–44 (Jan. 14, 1937).
6. Report No. 5 to A.P.P.A. An analysis of "smoothness" and the first stage in the development of a tester to grade it. Jan. 10, 1935. Instrumentation Studies VIII. *Paper Trade J.* 104, No. 11: 43–46 (March 18, 1937).
7. Report No. 6 to A.P.P.A. Effect of humidity in the physical testing of paper. Nov. 20, 1935. Instrumentation Studies XI. *Paper Trade J.* 104, No. 14: 40–46 (April 8, 1937).
8. Report No. 7 to A.P.P.A. Effect of relative humidity on physical properties with respect to the hysteresis effect in changes from one humidity to another. Nov. 20, 1935. Instrumentation Studies XII. *Paper Trade J.* 104, No. 15: 45–48 (April 15, 1937).
9. Report No. 8 to A.P.P.A. Adaptability of the G.E. reflection meter as a color analyzer. Parts I and II. Nov. 20, 1935. Instrumentation Studies XIII. *Paper Trade J.* 104, No. 18: 47–53; No. 19: 51–63 (May 6, 13, 1937).
10. Report No. 8 to A.P.P.A. Adaptability of the G.E. reflection meter as a color analyzer. Part III. The effect of infra-red fluorescent radiation upon "brightness" measurements obtained with the G.E. reflection meter. Dec. 18, 1936. Instrumentation Studies XIII. *Paper Trade J.* 104, No. 20: 45–49 (May 20, 1937).
11. Report No. 9 to A.P.P.A. A comparative study of the Bausch and Lomb glossmeter and the Ingersoll glarimeter. Nov. 20, 1935. Instrumentation Studies VII. *Paper Trade J.* 104, No. 2: 45–47 (Jan. 14, 1937).
12. Report No. 10 to A.P.P.A. A comparison of the Smith-Taber and the Gurley stiffness testers and a comparison of the Carter and the Gurley stiffness testers. Nov. 20, 1935. Instrumentation Studies XIV. A comparison of the Smith-Taber and the Gurley stiffness testers. *Paper Trade J.* 104, No. 21: 43–47 (May 27, 1937). Instrumentation Studies XV. A comparison of the Carter and Gurley stiffness testers. *Paper Trade J.* 104, No. 22: 43–45 (June 3, 1937).
13. Report No. 11 to A.P.P.A. The Bekk and Gurley smoothness testers and a discussion of methods for measuring smoothness of paper with special reference to a new electrical capacitance method. Nov. 20, 1935. Instrumentation Studies IX. The Bekk and Gurley smoothness testers. *Paper Trade J.* 104, No. 12: 62–66 (March 25, 1937). Instrumentation Studies X. A discussion of methods for measuring smoothness of paper with special reference to a new electrical capacitance method. *Paper Trade J.* 104, No. 13: 30–33 (April 1, 1937).
14. Report No. 12 to A.P.P.A. A correlation between the degree of sizing as determined by the Valley, TAPPI, and Currier methods. Nov. 20, 1935. Instrumentation Studies XVI. *Paper Trade J.* 104, No. 23: 45–46 (June 10, 1937).
15. Report No. 13 to A.P.P.A. A study of the transparency of tinted white glassine papers and the development of an instrument for its measurement and the Westinghouse Trans-O-Meter. Nov. 20, 1935. Instrumentation Studies XVII. *Paper Trade J.* 105, No. 2: 41–48; No. 3: 35–44 (July 8, 15, 1937).
16. Report No. 14 to A.P.P.A. Rate of penetration of oil through paper. Part I. Nov. 20, 1935. Instrumentation Studies XVIII. *Paper Trade J.* 105, No. 8: 39–42 (Aug. 19, 1937).
17. Report No. 14 to A.P.P.A. Rate of penetration of oil through paper. Part II. An improvement in the method of calculating rates and distances penetrated from data obtained on the I.P.C. photoelectric penetration meter. Dec. 30, 1937. Instrumentation Studies XXVII. *Paper Trade J.* 107, No. 18: 56–58 (Nov. 3, 1938).
18. Report No. 15 to A.P.P.A. Photoelectric device for the objective measurement of light scattered by small particles and surface fuzz of paper. Nov. 20, 1935. Instrumentation Studies XIX. *Paper Trade J.* 105, No. 9: 33–35 (Aug. 26, 1937).
19. Report No. 16 to A.P.P.A. Paper properties. Feb. 1, 1936. Instrumentation Studies II. *Paper Trade J.* 103, No. 26: 32–35 (Dec. 24, 1936); *Paper Mill* 59, No. 38: 35–42 (Sept. 19, 1936).
20. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part I. A general discussion of color and color measurements. Feb. 5, 1937. Instrumentation Studies XX. *Paper Trade J.* 105, No. 18: 135–141; No. 19: 27–39 (Oct. 28, Nov. 4, 1937).
21. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part II. The General Radio color comparator. Type 725-A. Feb. 5, 1937. Instrumentation Studies XXI. *Paper Trade J.* 105, No. 25: 46–50 (Dec. 16, 1937).
22. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part III. The Lange photoelectric reflection meter. Feb. 5, 1937. Instrumentation Studies XXII. *Paper Trade J.* 105, No. 27: 42–46 (Dec. 30, 1937).
23. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part IV. The Hunter multi-purpose reflectometer. Oct. 20, 1937. Instrumentation Studies XXIX. *Paper Trade J.* 107, No. 25: 29–40 (Dec. 22, 1938).
24. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part V. The Eimer and Amend improved reflection meter. Nov. 5, 1937. Instrumentation Studies XXVIII. *Paper Trade J.* 107, No. 20: 33–37 (Nov. 17, 1938).
25. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part VI. The Higgins reflection meter. Aug. 1, 1939. Instrumentation Studies XXXVII. *Paper Trade J.* 112, No. 1: 13–18, 20, 22 (Jan. 2, 1941).
26. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and

transmittance. Part VII. The Photovolt photoelectric reflection meter, Model 610. Feb. 8, 1943. Instrumentation Studies LVIII. *Tappi* 33, No. 10: 85–89A (Oct., 1950).
27. Report No. 17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part VIII. The Hunter color and color difference meter. Jan. 1, 1950. Instrumentation Studies LXV. *Tappi* 34, No. 9: 143–158A (Sept., 1951).
28. Report No.17 to A.P.P.A. A study of photoelectric instruments for the measurement of color: reflectance and transmittance. Part IX. The Densichron as a reflection meter. Feb. 1, 1950. Instrumentation Study LXIV. *Tappi* 34, No. 8: 126–132A (Aug., 1951).
29. Report No. 18 to A.P.P.A. The measurement of elasticity and compressibility by the Bekk hardness tester. Feb. 15, 1937. Instrumentation Studies XXIII. *Paper Trade J.* 106, No. 2: 42–47 (Jan. 13, 1938).
30. Report No. 19 to A.P.P.A. Variations in physical properties due to their nonuniformities. Feb. 15, 1937. Instrumentation Studies XXIV. *Paper Trade J.* 106, No. 3: 42–44 (Jan. 20, 1938).
31. Report No. 20 to A.P.P.A. The Williams smoothness tester. Feb. 15, 1937. Instrumentation Studies XXV. *Paper Trade J.* 106, No. 4: 38–42 (Jan. 27, 1938).
32. Report No. 21 to A.P.P.A. Penetration of papers by liquids and solutions. Part I. General discussion of the phenomena. Dec. 23, 1938. Instrumentation Studies XXXIV. *Paper Trade J.* 110, No. 4: 44–50 (Jan. 25, 1940).
33. Report No. 21 to A.P.P.A. Penetration of papers by liquids and solutions. Part II. The Barss, Knobel, and Young news penetration tester. June 1, 1937. Instrumentation Studies XXVI. *Paper Trade J.* 105, No. 26: 35–42 (Dec. 23, 1937).
34. Report No. 21 to A.P.P.A. Penetration of papers by liquids and solutions. Part III. The Larocque surface oil absorption test. June 30, 1938. Instrumentation Studies XXXIII. *Paper Trade J.* 109, No. 15: 19–26 (Oct. 12, 1939).
35. Report No. 22 to A.P.P.A. A study of instruments for the measurement of opacity of paper. Part I. A general discussion of opacity and methods for the measurement of opacity. Instrumentation Studies XXX. *Paper Trade J.* 109, No. 4: 29–34 (July 27, 1939).
36. Report No. 22 to A.P.P.A. A study of instruments for the measurement of opacity of paper. Part II. Calibration of the Bausch and Lomb opacimeter. Instrumentation Studies XLVIII. *Paper Trade J.* 119, No. 17: 27–30 (Oct. 26, 1944).
37. Report No. 22 to A.P.P.A. A study of instruments for the measurement of opacity of paper. Part III. The Weston opacity meter and the Welsh Densichron. Feb. 1, 1950. Instrumentation Studies LXX. *Tappi* 35, No. 5: 185–190A (May, 1952).
38. Report No. 23 to A.P.P.A. Schopper bending endurance tester. Instrumentation Studies XXXI. *Paper Trade J.* 109, No. 5: 34–40 (Aug. 3, 1939).
39. Report No. 24 to A.P.P.A. The measurement of compressibility of paper under static load. Part I. Instrumentation Studies XXXII. *Paper Trade J.* 109, No. 13: 18–22 (Sept. 28, 1939).
40. Report No. 24 to A.P.P.A. The measurement of compressibility of paper under static load. Part II. Federal compressibility gauge, Model 691 B-30. May 28, 1938.
41. Report No. 25 to A.P.P.A. Gurley-Hill S-P-S tester. Instrumentation Studies XXXVI. *Paper Trade J.* 110, No. 23: 27–33 (June 6, 1940).
42. Report No. 26 to A.P.P.A. Clark paper softness tester, with an important note on the Gurley stiffness tester. Instrumentation Studies XXXV. *Paper Trade J.* 110, No. 7: 29–37 (Feb. 15, 1940).
43. Report No. 27 to A.P.P.A. Thwing initial tear tester. Instrumentation Studies XXXVIII. *Paper Trade J.* 113, No. 4: 21–26 (July 24, 1941).
44. Report No. 28 to A.P.P.A. Thwing multiple fold tester. Instrumentation Studies XXXIX. *Paper Trade J.* 114, No. 13: 20, 22, 24, 26, 28, 30 (March 26, 1942).
45. Report No. 29 to A.P.P.A. Measurement of the tensile strength of paper. Part I. General considerations of the factors affecting this measurement. Instrumentation Studies XL. *Paper Trade J.* 115, No. 5: 12–18; No. 7: 13–22; No. 19: 18–22 (July 30, Aug. 13, Nov. 5, 1942).
46. Report No. 29 to A.P.P.A. Measurement of the tensile strength of paper. Part II. The Scott Serigraph, Model J3. Instrumentation Studies XLI. *Paper Trade J.* 115, No. 26: 14–21 (Dec. 24, 1942).
47. Report No. 29 to A.P.P.A. Measurement of the tensile strength of paper. Part III. The Amthor universal tensile strength tester. Instrumentation Studies XLII. *Paper Trade J.* 116, No. 6: 10–12 (Feb. 11, 1943).
48. Report No. 29 to A.P.P.A. Measurement of the tensile strength of paper. Part IV. The Schopper electrically driven strength tester. Instrumentation Studies XLIII. *Paper Trade J.* 116, No. 6: 13–14 (March 4, 1943).
49. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part I. General discussion of the present status of the measurement of water-vapor permeability. Instrumentation Studies XLIV. *Paper Trade J.* 116, No. 14: 11–15; No. 23: 10–13 (April 8, June 10, 1943).
50. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part II. An electric sword hygrometer for measuring the relative humidity of air inside packages or other enclosures. Instrumentation Studies XLV. *Paper Trade J.* 116, No. 24: 16–19; 117, No. 1: 12–15 (June 17, July 1, 1943).
51. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part III. Techniques for measuring water-vapor transfer—a progress report. Instrumentation Studies XLIX–L. *Paper Trade J.* 118, No. 2: 23–29, 30–31 (Jan. 13, 1944).
52. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part IV. Bibliographic study. Instrumentation Studies LI. *Paper Trade J.* 121, No. 13: 68, 74, 78, 80, 86, 91; No. 16: 33–42 (Sept. 27, Oct. 18, 1945).
53. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part V. Progress report on the development of two new electric methods for the measurement of water-vapor permeability. Instrumentation Studies LII. *Paper Trade J.* 122, No. 1: 35–44 (Jan. 3, 1946).
54. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part VI. Controlled relative humidity cabinet in which specimens may be weighed without removal from the conditioned atmosphere. B. Brief discussion of the measurement of relative humidity. Instrumentation Studies LIV. *Paper Trade J.* 122, No. 8: 41–46 (Feb. 21, 1946).
55. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part VII. Progress report on the further development of a new electric "dynamic" method for the measurement of water-vapor permeability. Instrumentation Studies LIII. *Paper Trade J.* 122, No. 6: 37–42 (Feb. 7, 1946).
56. Report No. 30 to A.P.P.A. Penetration of papers by water vapor. Part VIII. Development of a method for the measurement of water-vapor permeability at low temperatures. Instrumentation Studies LVI. *Tappi* 33, No. 8: 84–96 (Aug., 1950).
57. Report No. 31 to A.P.P.A. Determination of the bonding strength of paper. Part I. Preliminary study of existing methods. Feb. 3, 1941.
58. Report No. 31 to A.P.P.A. Determination of the bonding strength of paper. Part II. Preliminary study of existing methods—continued. Jan. 27, 1942.
59. Report No. 31 to A.P.P.A. Determination of the bonding strength of paper. Part III. Progress report on the development of a new method. Instrumentation Studies LV. *Paper Trade J.* 123, No. 18: 24, 26, 28–29; No. 19: 24, 26, 28, 30, 32, 34 (Oct. 31, Nov. 7, 1946).
60. Report No. 32 to A.P.P.A. A summary of instrumentation reports including the technique of evaluating instruments. Feb. 10, 1941.
61. Report No. 33 to A.P.P.A. Instruments for measuring the properties of paper. Feb. 6, 1941.
62. Report No. 34 to A.P.P.A. Color blindness. Part I. Feb. 12, 1941.
63. Report No. 34 to A.P.P.A. Color blindness. Part II. Progress report on the study of color blindness by means of a monochromatic colorimeter. *J. Optical Soc. Am.* 37, No. 5: 363–387 (May, 1947).
64. Report No. 35 to A.P.P.A. Tearing strength of paper. Part I. Instrumentation Studies XLVI. *Paper Trade J.* 118, No. 5: 13–19 (Feb. 3, 1944).
65. Report No. 35 to A.P.P.A. Tearing strength of paper. Part II. The Brecht-Imset through-tear tester. Feb. 1, 1948. Instrumentation Studies LIX. *Tappi* 33, No. 11: 109–118A (Nov., 1950).
66. Report No. 36 to A.P.P.A. Measurement of the stretch of paper. Instrumentation Studies XLVII. *Paper Trade J.* 118, No. 26: 12–16; 119, No. 1: 24, 26, 28, 30; No. 2: 24, 26, 28, 30 (June 29, July 6, 13, 1944).
67. Report No. 37 to A.P.P.A. The Pratt & Whitney electro-limit paper gage. Sept. 15, 1942.
68. Report No. 38 to A.P.P.A. The Beach puncture tester. Aug. 24, 1943. Instrumentation Studies LX. *Tappi* 33, No. 12: 114–122A (Dec., 1950).
69. Report No. 40 to A.P.P.A. Equilibrium relative humidities above saturated salt solutions at various temperatures. Instrumentation Studies LVII. *Tappi* 33, No. 9: 96–99 (Sept., 1950).
70. Report No. 41 to A.P.P.A. General discussion of the measurement of adhesion and cohesion. Feb. 15, 1945. Instrumentation Studies LXIX. *Tappi* 35, No. 4: 155–162A (April, 1952).

71. Report No. 42 to A.P.P.A. Methods of measuring the moisture content of paper. Part I. A study of the effect of the moisture content on the electrical resistance of paper and an evaluation of the Hart moisture meter and the moisture register. Feb. 1, 1947. Instrumentation Studies LXXI. *Tappi* 35, No. 6: 168–182A (June, 1952).
71a. Report No. 42 to A.P.P.A. Methods of measuring the moisture content of paper. Part II. The Fielden Drimeter. Feb. 5, 1951. Instrumentation Studies LXXII. *Tappi* 35, No. 7: 138–148A (July, 1952).
72. Report No. 43 to A.P.P.A. Erasability of paper. Part I. A general discussion of erasability. *Tappi* 34, No. 2: 89–92A (Feb., 1951).
73. Report No. 43 to A.P.P.A. Erasability of paper. Part II. Progress report on a study of erasability. Feb. 15, 1948. Instrumentation Studies LXII. *Tappi* 34, No. 3: 112–118A (March, 1951).
74. Report No. 43 to A.P.P.A. Erasability of paper. Part III. Progress report on a study of erasability. Feb. 1, 1949. Instrumentation Studies LXIII. *Tappi* 34, No. 7: 103–119A (July, 1951).
74a. Report No. 43 to A.P.P.A. Erasability of paper. Part IV. A proposed method for evaluating the erasing quality of paper. Feb. 1, 1951. Instrumentation Studies LXVII. *Tappi* 35, No. 1: 137–139A (Jan., 1952).
75. Report No. 44 to A.P.P.A. The K.B.B. galvanic size tester. Jan. 15, 1950. Instrumentation Study LXVI. *Tappi* 34, No. 10: 137–148A (Oct., 1951).
75a. Report No. 45 to A.P.P.A. Evaluation of dirt in paper. Part I. Discussion of methods for speck counting and analysis. Feb. 1, 1951. Instrumentation Studies LXVIII. *Tappi* 35, No. 3: 148–149A (March, 1952).

Additional References

76. Van den Akker, J. A., The fundamentals of instrumentation. *Paper Trade J.* 109, No. 1: 39–42 (July 6, 1939).
77. American Paper and Pulp Association. The dictionary of paper. 2d ed. New York, A.P.P.A., 1951.
78. Van den Akker, J. A., The instrumentation program at The Institute of Paper Chemistry. *Pulp and Paper Mag. Canada* 48, No. 3: 163–165, 174 (Feb., 1947).
79. Van den Akker, J. A. Chromaticity limitations of the best physically realizable three-filter photoelectric colorimeter. *J. Optical Soc. Am.* 27, No. 12: 401–407 (Dec., 1937).
80. Wicker, Dan B., The fundamentals of glassine transparency. *Paper Trade J.* 104, No. 17: 31–40 (Oct. 21, 1937); 107, No. 14: 44–52 (Oct. 27, 1938); 110, No. 1: 36–42 (Jan. 4, 1940); *Tech. Assoc. Papers* 20: 390–399 (1937); 21: 269–277 (1938); 22: 388–394 (1939).

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Positions Wanted

E173-52. Papermaker. 15 years' technical and practical experience in fine paper; superintendent of fourdrinier kraft, sulphite, and groundwood operation. Can plan and supervise installation of papermaking equipment. Desires position in management, production, or sales.

E183-52. Chemical Engineer. 31. Married. Diversified pulp and paper experience, newsprint, acid and alkaline pulping, deinking. Sound engineering background with practical experience in production development, including instrumentation. Registered professional engineer. Desires position leading to supervisory capacity. Prefers location on West Coast or Middle West.

E184-52. Engineer. Available at once. Graduate engineer. More than 15 years' experience in pulp, paper and insulation board, mill design, and mill operation. Desires permanent connection as executive assistant or junior executive nature.

E185-52. Pulp and Paper Graduate. 36. Family. Extensive experience in engineering, lay-out, start-up, and operation of bleached semichemical pulp mill. At present superintendent of 120-ton bleached semichemical pulp mill using hardwoods. Desires position with company planning or operating bleached semichemical mill or with company selling semichemical process equipment.

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E187-52. Plant Engineer with 20 years' experence in groundwood and sulphite specialty mills desires position in Northern or Midwestern mill. Excellent references.

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P215-52. Paper Chemist, to carry on technical research program in connection with specifications for papers used as card stock in IBM machines. Excellent working and living conditions, good salary, moving expenses paid, exceptional employee benefits. Challenging, permanent future.

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P218-52. Salesman experienced in multiwall bag field to cover New England and Middle Atlantic Territory. If living within area need not change location.

P219-52. Papermaker qualified to be a superintendent or assistant superintendent in a lightweight specialties mill. Technical background desirable.

P220-52. Chemist or Chemical Engineer. Recent graduate with pulp and paper experience in laboratory or mill. Should be interested in the utilization of cellulosic agricultural by-products. Commercial research laboratory.

P221-52. Chemical Engineer or Chemist for research and development position with chemical manufacturing company supplying the pulp and paper industry.

P222-52. Control Chemist and Quality Control Foreman for mill in New York State.

P224-52. Chemical Engineer or technically trained man for selling and servicing necessary basic ingredient to paper and board manufacturers. Must be willing to travel. Our company is large with well-established national distribution. Replies will be considered confidential and should include complete résumé of general qualifications, together with age, experience, and salary expected.

P226-52. Paper Coating Chemist for laboratory of Upper Midwest manufacturer of bleached and unbleached groundwood, sulphite, kraft pulp, printing, and converting papers. Prefer chemist or chemical engineering graduate with 2–4 years' applied research experience in paper coating field. Reply giving personal history, experience, and salary expected.

P227-52. Research man with coating formulation experience for laboratory of Upper Midwest insulation board manufacturer. Prefer chemistry or chemical engineering graduate with 1–2 years' experience in paint or insulation board industry. Will consider recent chemical engineering graduate. Reply giving personal history, experience, and salary expected.

P228-52. Chemist or Chemical Engineer. 30–40 years. Good personality, good mixer. Excellent opportunity with midwest boxboard mill.

P229-52. Paper Mill Engineers. The Great Northern Paper Co. is starting a major plant expansion of pulp, power, and paper facilities. Permanent positions are open in the Engineering Department for engineers qualified to take responsibility for design of different sections of the new construction. If interested send detailed résumé of experience and background to: Chief Engineer, Great Northern Paper Co., Millinocket, Me.

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Calendar of TAPPI Meetings

Seventh Engineering Conference, Morrison Hotel, Chicago, Ill., October 13–16, 1952.

Fibrous Agricultural Residues Conference, Northern Regional Research Laboratory, Peoria, Ill., October 27–28, 1952 (Rooms at Pere Marquette Hotel).

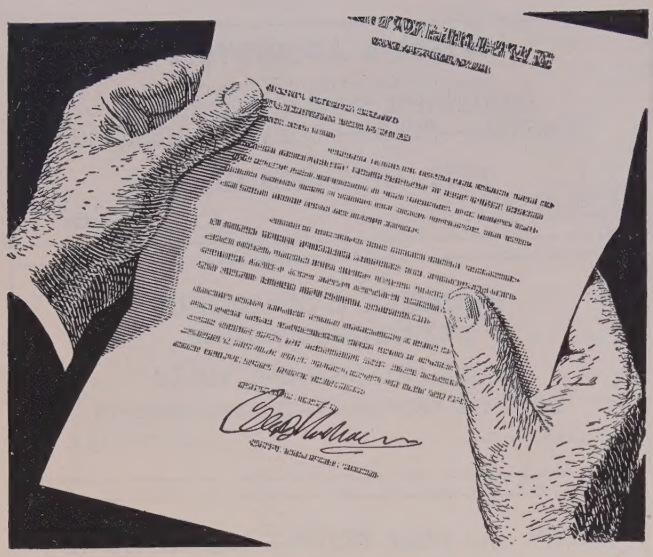
Plastics Conference, College of Forestry, State University of New York, Syracuse, N. Y., November 5–6, 1952.

Alkaline Pulping Conference, Battle House, Mobile, Ala., November 12–14, 1952.

Corrugated Containers Conference, Schroeder Hotel, Milwaukee, Wis., November 20–21, 1952.

Annual Meeting, Commodore Hotel, New York, N. Y., February 16–19, 1953.

New England Section:
October 10–11, 1952, Berkshire Inn, Great Barrington, Mass.



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INDEX TO ADVERTISERS

American Cyanamid Co. (Calco Div.)	2nd Cover
American Cyanamid Co. (Industrial Chemicals)	51 A
Ansul Chemical Co.	89 A
Babcock & Wilcox Co.	7 A
Beloit Iron Works	1 A
Bird Machine Co.	69 A
Black-Clawson Co. (Shartle & Dilts)	9 A
Buffalo Electro-Chemical Co., Inc.	33 A
Butterworth & Sons, H. W.	194 A
Cleary Corp., W. A.	84 A
Clinton Foods, Inc.	58 A
Columbia-Southern Chemical Corp.	4th Cover
Combustion Engineering-Superheater Inc.	79 A
Cowles Co., Inc., The	57 A
Crane Co.	83 A
Denver Equipment Co.	37 A
Dicalite Div. (Great Lakes Carbon Corp.)	75 A
Dorr Co.	8 A
Draper Brothers Co.	130 A
Eastwood-Nealley Corp.	144 A
Ebasco Services, Inc.	95 A
Foxboro Co.	18 A–19 A
Geigy Co., Inc.	97 A
Glidden Co., The	61 A
Gurley, W. & L. E.	94 A
Harrison Manufacturing Co.	63 A
Hermann Manufacturing Co.	91 A
Huber Corp., J. M.	4 A
Hubinger Co., The	93 A
Huyck & Sons, F. C.	66 A
Infilco, Inc.	3 A
Johns-Manville Corp. (Industrial Div.)	65 A
Johns-Manville Corp. (Celite)	49 A
Johnson Corp., The	97 A
Kelco Co.	21 A
Langston Co., Samuel M.	73 A
Magnus Chemical Co.	86 A
Mallinckrodt Chemical Works	94 A
Mason-Neilan Regulator Co.	27 A
Midwest-Fulton Machine Co., The	95 A
Monsanto Chemical Co. (Merrimac Div.)	29 A
Moore & White Co.	23 A
Morden Machines Co.	35 A
Mt. Vernon-Woodberry Mills (Turner-Halsey)	17 A
National Aluminate Corp.	43 A
Noble & Wood Machine Co.	41 A
Nopco Chemical Co.	45 A
Norton Co.	6 A
Pennsylvania Salt Manufacturing Co.	71 A
Perkins & Son, Inc., B. F.	96 A
Philadelphia Quartz Co.	88 A
Prior Chemical Corp.	16 A
Pusey & Jones Corp.	53 A
Ravbestos-Manhattan Inc. (Manhattan Rubber Div.)	31 A
Reichhold Chemicals, Inc.	39 A
Rice Barton Corp.	59 A
Rohm & Haas Co.	55 A
Ross Engineering Corp., J. O.	47 A
Shuler & Benninghofen	2 A
Sindar Corp.	90 A
Socony-Vacuum Oil Co., Inc.	25 A
Southern Clays, Inc.	77 A
Sprout-Waldron & Co., Inc.	60 A
Sutherland, Inc.	15 A
Taylor-Stiles & Co.	96 A
Texas Gulf Sulphur Co.	81 A
Titanium Pigment Corp.	3rd Cover
Tracerlab, Inc.	92 A
Union Screen Plate Co. of Canada, Ltd.	64 A
Vanderbilt Co., Inc., R. T.	11 A
Virginia Smelting Co.	85 A
Waldron Corp., John	87 A
Wallace & Tiernan Co., Inc.	62 A
Weyerhaeuser Timber Co. (Pulp Div.)	13 A
Witco Chemical Co.	98 A

PROFESSIONAL SERVICES

American Defibrator, Inc.	193 A
Chemical Linings, Inc.	193 A
Chicago Testing Laboratory	193 A
The H. K. Ferguson Co.	193 A
Gilbert Associates, Inc.	193 A
G. D. Jenssen Co., Inc.	193 A
Knowles Associates	193 A
Chas. T. Main, Inc.	193 A
Myers & Addington	193 A
Roderick O'Donoghue	193 A
Pulp and Paper Testing Laboratories	193 A
Pfeifer & Shultz	193 A
J. E. Sirrine Co.	193 A
Stadler, Hurter & Co.	193 A

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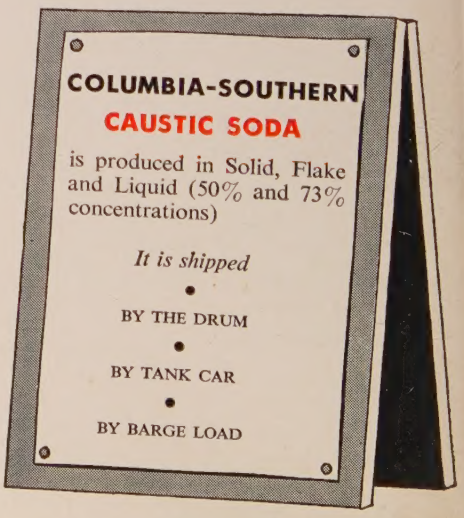
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